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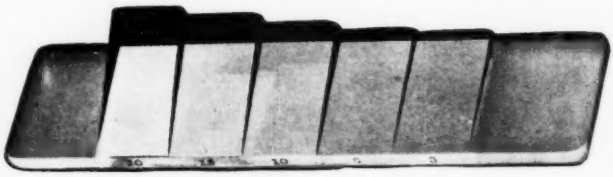

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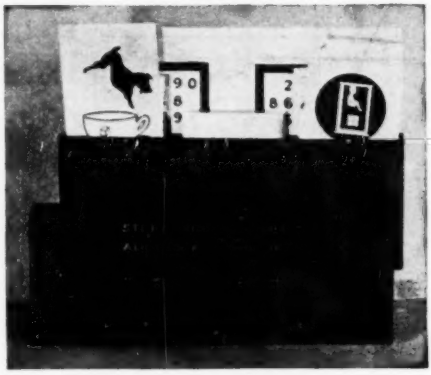

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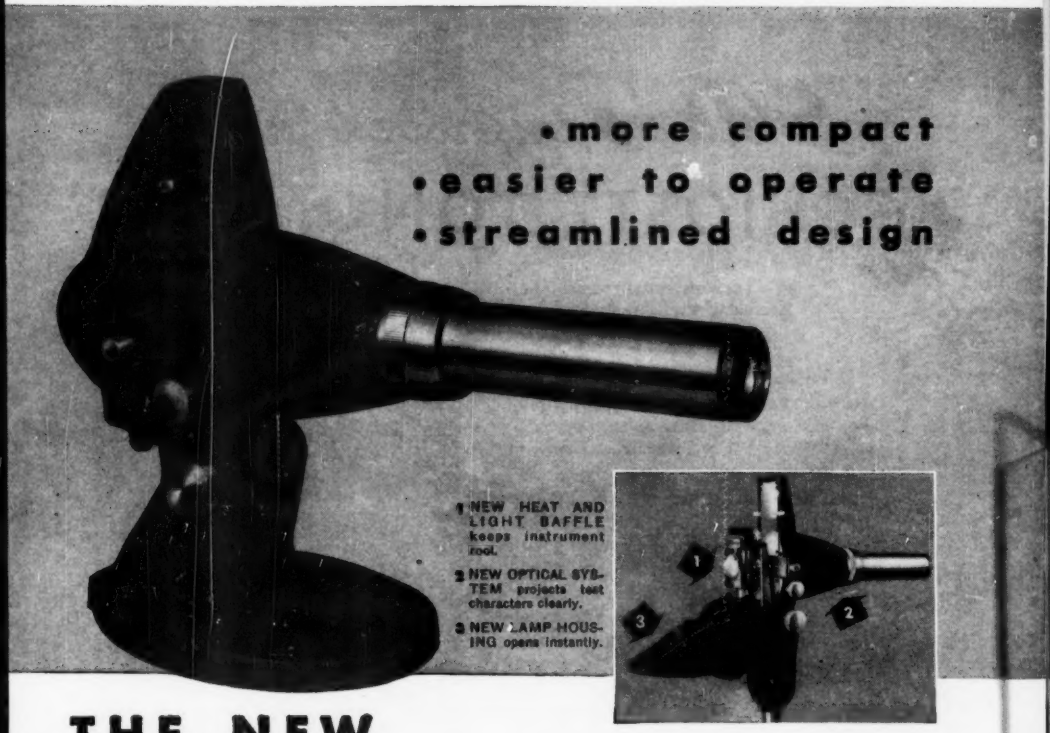

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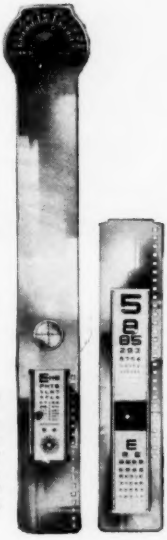

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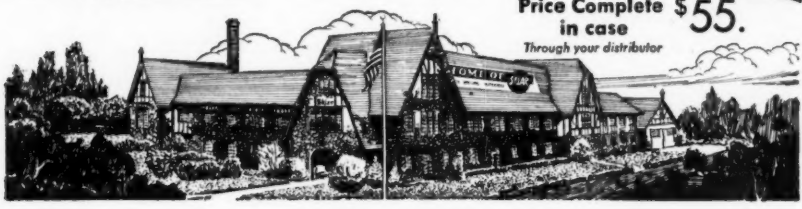

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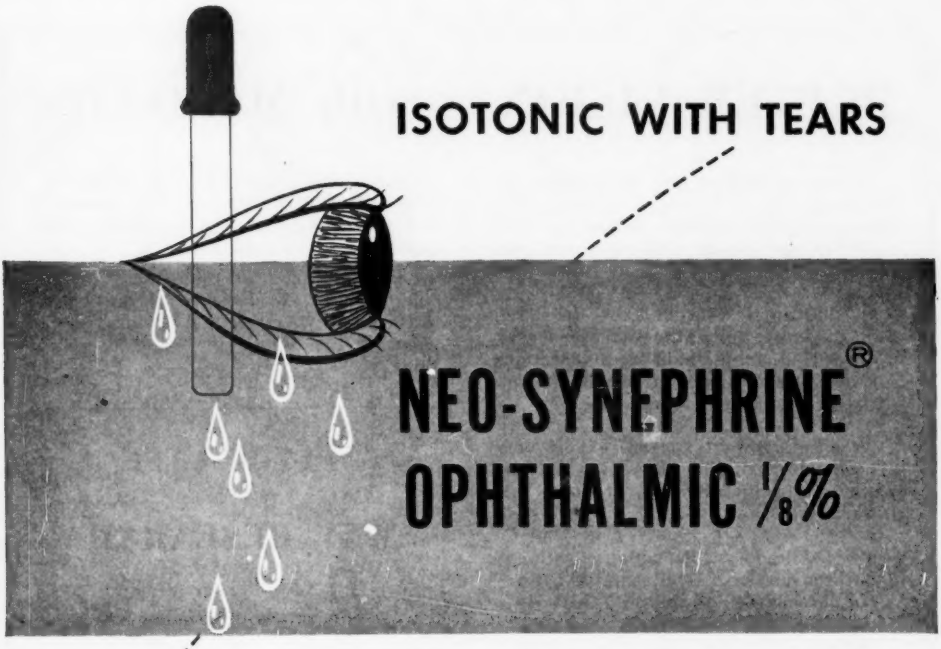

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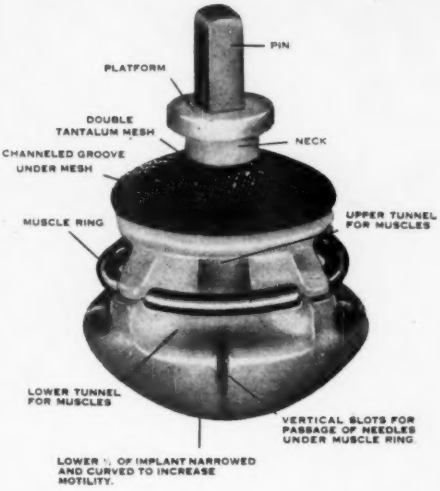

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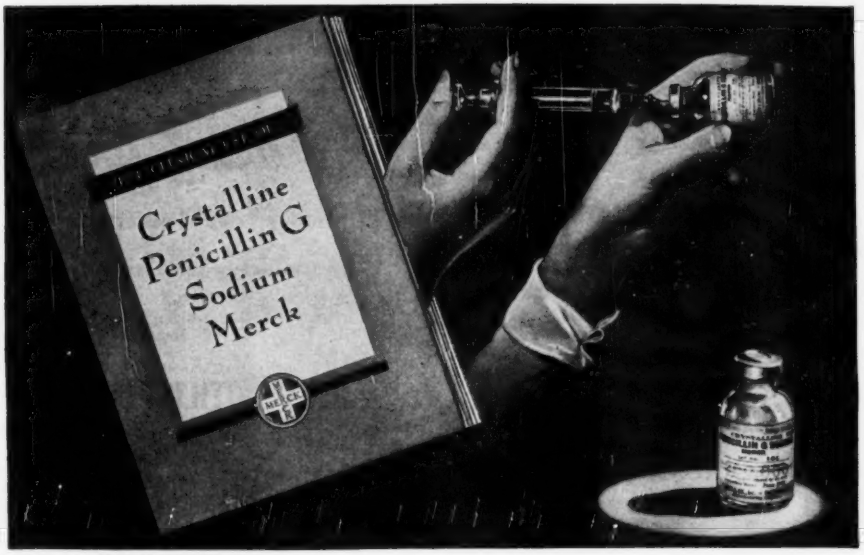

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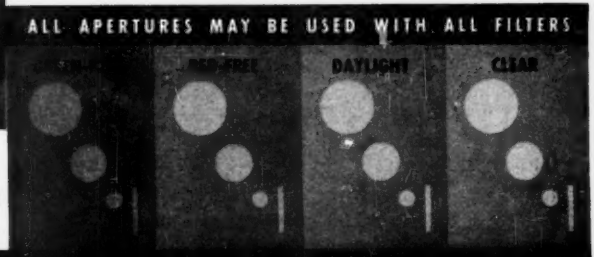

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ARCHIVES OF OPHTHALMOLOGY

VOLUME 41 (old series Volume 98) JANUARY 1949 NUMBER 1

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BETA RADIATION THERAPY

A. D. RUEDEMANN, M.D.
DETROIT

METHOD OF APPLICATION

IN THE treatment of certain diseases of the eye, beta radiation from decay products of radium is made use of by means of a beta ray applicator.

Radon is sealed in a small glass sphere (fig. 2, *R*) in the applicator. The diameter of this sphere is about 4 mm. and the thickness of the wall about 0.1 mm. The glass sphere is inserted into a thin copper capsule (fig. 2, *2, 3*), and a spring holds it tightly against the open window (at *2*) of the capsule. The metal capsule with sphere is inserted into an open end brass holder (*1, 4*), with a wall 2 mm. thick. On contact of the open window with the tissue to be treated, only the thin glass window separates the tissue from the radon. Alpha rays are absorbed in the glass window. Radiation transmitted through this window consists of about 97 per cent beta rays and 3 per cent gamma rays.

Dosage of Beta Radiation.—The dosage usually used with the beta ray applicator for contact therapy is 5,000 millicurie seconds. For a 250 millicurie (measured for emission of gamma rays) radon bulb, the treatment time is, therefore, twenty seconds. This dose corresponds to about 600 r. It will produce pronounced erythema of the skin within three days.

Protection in Beta Radiation Therapy.—Distance from the source of radiation is the best protection. Since this beta ray applicator also emits gamma rays, it is equipped with a long handle, and a double length tongue blade is used to hold the lid during treatment. When not in use, the applicator is placed in a lead container with walls 2 inches (5 cm.) thick.

The speculum must be adjusted before the applicator is placed on the lesion. Should it slip during treatment, the applicator must be removed while it is adjusted. The glass window of the beta ray applicator must be pointed only toward lesion to be treated, and never toward any other part of the patient or toward the ophthalmologist.

When the ophthalmologist is holding the beta ray applicator, filled with 250 millicuries of radon, his fingers will receive the daily tolerance dose of 0.1 r within five minutes. This would permit his giving about ten treatments, allowing for a treatment time of twenty seconds and time for handling between treatments, provided he is not exposed to any other type of radium or roentgen radiation. The treatment time must be accurately determined with the stopwatch.

Factors in Therapy.—1. Treatment should be either by direct contact or by spray radiation. 2. The time of treatment varies according to the type of lesion, the strength of the tube and the reaction to treatment. 3. The time factor is important in treatment of corneal lesions; it is difficult for children and for some adults to hold still for over twenty-five seconds. Use of a stronger tube with a short time factor is advisable. 4. Age is not a factor; this treatment

has been used with infants as young as 6 months. 5. The only discomfort to the patient is his own fear. 6. As a measure of economy, a number of patients should be arranged for treatment at one time. This reduces the cost per patient and saves time. 7. Separate record cards are kept for instant reference.

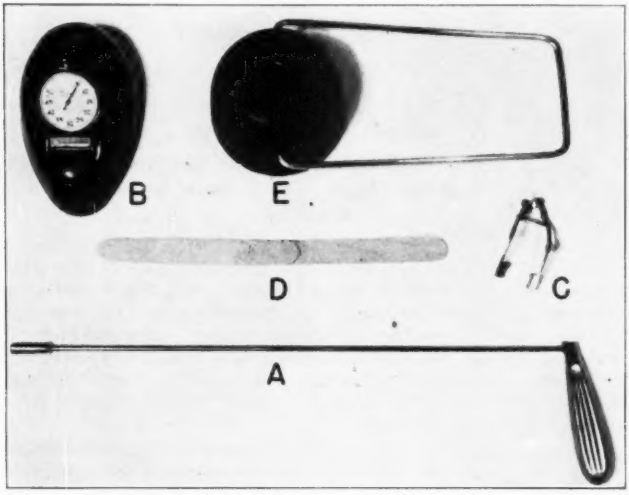

Fig. 1.—Beta ray applicator (*A*), 40 cm. in length. *B* is the stopwatch; *C*, the eye speculum; *D*, the double length tongue blade, and *E*, the lead box.

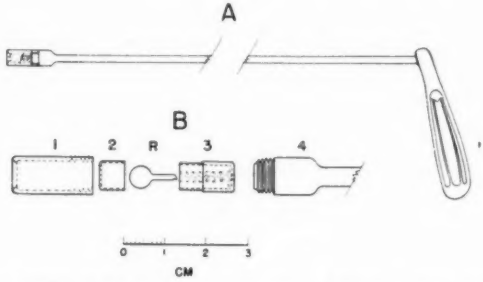

Fig. 2.—Drawing of the beta ray applicator. *A* shows the beta ray applicator assembled; *B*, details of the applicator, as follows: *R*, radon-filled thin glass bulb; *2* and *3*, thin metal capsule with open window at *2*; *1* and *4*, heavy brass holder with open window at *1*.

CONDITIONS SUITABLE FOR IRRADIATION

The conditions which are suitable for beta radiation therapy are overgrowths of the lid, of minor importance to vision but of major

importance to appearance. Large, infiltrating growths suggestive of carcinoma should be excised and treated with gamma rays of radium or by roentgen radiation. When the growth is small, shallow or difficult to excise, application of the beta radiation of radium is the treatment of choice. Although beta rays are of low voltage, only one-half a given surface dose is absorbed in 2 mm. of tissue, and all minor lesions are easily and successfully treated. Small marginal growths, to which it is difficult to apply gamma or roentgen rays, can be given one or two applications, and they will be destroyed with little or no loss of lashes. Beta radiation can be used as well for small angiomas in babies. The time of application is short, and, if a simple holding technic is used, no anesthetic is required. In treatment of other cutaneous lesions around the eyes, use of beta radiation is suggested, as it leaves no discoloration of the skin or depigmentation and there is no tendency to a deep bronzing effect.

Vernal Conjunctivitis.—Large polypoid masses are treated as follows:

1. If the polyps are of long standing and fibrotic, they should be excised.

2. Gamma radiation may be given. The eye must be carefully screened with lead plates, the lid everted and the applicator directly applied. This therapy gives prompt relief but may need to be repeated. Cold compresses and irrigation minimize edema and reaction.

3. The larger polyps having been excised or reduced in size, beta radiation can be directly applied to the individual polyps, especially those along the superior aspect of the tarsus. Mild catarrhal lesions may be treated with spray radiation. The effect is prompt and lasting. Individual polyps and small areas are easily reached.

4. Except in urgent cases, in which use of gamma radiation is advisable, beta radiation can be easily and quickly applied in children. The end results are similar to those of gamma rays.

5. The long applicator, to evert the lower lid, and the double length tongue blade (page 2) are safety aids in the therapy.

Conjunctival Lesion.—Small lesions on the bulbar conjunctiva can be treated directly with beta radiation. Small, superficial growths require but one application, rarely two, by direct contact. Vascular growths are more resistant but can be treated by direct contact. Spray radiation is of value and is given by moving the applicator over the area to be treated, so that the entire area receives a small amount of this radiation and the applicator is not in contact with one area for any period of time. Enlargement of the caruncle, enlarged pinguecula and beginning pterygium are well treated by direct application, as are small pseudopterygia. Large true pterygia and large pseudopterygia are treated with spray radiation over the corneal portion combined

with direct application along the limbal portion. Recurring pterygia having interstitial vascular trunks require contact irradiation over most of the extent to eliminate deep vascularization. Marginal carcinoma is satisfactorily treated by direct contact.

Corneal Lesions.—Deep or superficial keratitis, whether due to tuberculosis, syphilis or brucellosis, is known to have been successfully treated with beta radiation. General therapy should be directed to the etiologic factor. Corneal nebulas following ulcer, trauma or allergy are usually cleared, with little residual scarring. Maculas of the cornea can be substantially reduced in area and sufficiently cleared so that patients are able to carry on without corneal transplantation. Vascularized leukoma can be treated, so that the hazard of vascularization of a corneal transplant is lessened. Corneal transplants with a tendency to vascularization can be treated to prevent complete vascularization. Diminution in the area of corneal scarring and reduction in density are major factors in beta radiation therapy.

SUMMARY

There is a twofold hazard in the use of radiation therapy: (1) to the patient, due to overdosage, faulty application or severe reaction; and (2) to the ophthalmologist. The value of radiation is stressed because of its usefulness in treatment of so many conditions previously supposed to be incurable. Use of roentgen, gamma or beta radiation offers a valuable therapeutic adjunct in ophthalmology. To date, there has been no definite evidence of injury to the eye with beta radiation. In several cases of severe corneal leukoma, excessive treatment with beta radiation produced small perforating ulcers and enucleation was necessary. Roentgen and gamma radiation therapy may produce cataract and injure the retina permanently. It is possible to use the various forms of radiation in a single case. Care must be taken to allow for subsidence of reaction if such a procedure is indicated Photographs and drawings are valuable aids in progress notes.

1633 David Whitney Building (26).

MOTOR BLOCK OF EXTRAOCULAR MUSCLES BY DEEP ORBITAL INJECTION

HAROLD GIFFORD Jr., M.D.
OMAHA

THE VALUE of retrobulbar anesthesia has been appreciated by the majority of ophthalmic surgeons ever since Elschnig's [1] work was published, in 1925. He pointed out that this method of anesthesia produced a lowering of the intraocular tension, as well as anesthesia. Elschnig,[2] Grósz,[3] Dunphy,[4] Greenwood and Grossman,[5] my brother, Sanford Gifford,[6] and others, all expressed the belief that retrobulbar anesthesia reduced the percentage of cases of loss of vitreous in cataract extractions. In my study [7] on loss of vitreous, I demonstrated that the extraocular muscles were capable of producing the massive losses that occur in about 10 per cent of cases of loss of vitreous. The tonus of these muscles also contributes to the production of the smaller losses of vitreous. I stated the belief that a more complete motor block of the extraocular muscles would prevent the massive loss of vitreous and reduce the smaller losses to a minimum. A review of the literature revealed little on the production of motor block. In the latest edition of his text, Pitkin [8] gives a definite plan for obtaining both a motor and a sensory block. This reads well and is accompanied with excellent

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Read before the Section on Ophthalmology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 25, 1948.

1. Elschnig, A.: Extraction of Senile Cataract in Capsule, Am. J. Ophth. **8**:355-361, 1925.

2. Elschnig, A.: Hilfsverfahren bei der Alterstarextraction, Arch. f. Augenh. **98**:300-305, 1927.

3. Grósz, E.: L'extraction de la cataracte d'après 15,000 opérations, Arch. d'opht. **53**:161-165, 1936.

4. Dunphy, E. H.: Loss of Vitreous in Cataract Extraction, J. A. M. A. **89**: 2254-2257 (Dec. 31) 1927.

5. Greenwood, A., and Grossman, H. P.: An Analysis of 1,343 Intracapsular Cataract Extractions, Forty-Eight Operations Following Verhoeff's Method. Tr. Am. Ophth. Soc. **33**:353-361, 1935.

6. Gifford, S. R.: Prevention of Complications in the Cataract Operation, Illinois M. J. **68**:243-245, 1935.

7. Gifford, H., Jr.: A Study of Vitreous Pressure in Cataract Surgery, Tr. Am. Ophth. Soc. **44**:435-492, 1946.

8. Pitkin, G. P.: Conduction Anesthesia in General Surgery, Philadelphia, J. B. Lippincott Company, 1946, pp. 333 and 374.

illustrations, but in my hands the method has failed to produce the desired results.

After I had measured 50 skulls and dissected many orbits in the cadaver with this problem in mind, the reasons for the poor results became obvious. First, the average distance of the anterior edge of the optic foramen from the inferior orbital margin was found to be 5.02 cm. (fig.1). In the smallest skull the distance was 4.5 cm., and in

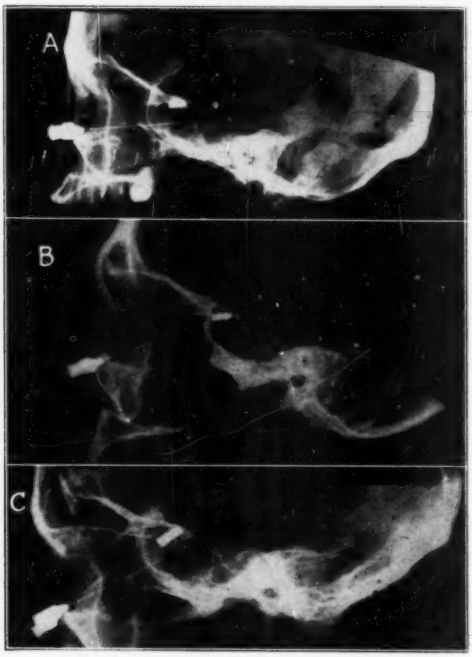

Fig. 1.—Shortest orbit, 5.5 cm., with the 5 cm. needle in place; *B*, longest orbit, 5.8 cm., with the 5 cm. needle in place; *C*, average orbit, 5.02 cm., with 5 cm. and 3.5 cm. needles in place.

the largest, 5.8 cm. It was obvious that the usually recommended 3.5 cm. needle could not possibly block the motor nerves as they enter the orbit. Second, the ciliary ganglion lies at least 4.5 cm. from the inferior orbital rim. Duke-Elder [9] placed the ganglion just inside the zonule of Zinn, on the lateral side of the optic nerve. This is where

9. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 1, p. 195.

I found it, from 4.5 to 5 cm. back from the inferior orbital margin. Third, in the ophthalmic and anatomic literature there exists considerable confusion and lack of detail as to where and how the motor and sensory nerves enter the orbit.[10]

In the cadavers I dissected the pattern was constant. The fourth nerve, to the superior oblique muscle, is definitely outside the muscle cone. It runs along the upper edge of the ophthalmic branch of the trigeminal nerve and enters the superior orbital fissure, together with the frontal branch of the fifth cranial nerve, under the periosteum It can be blocked only accidentally from an injection inside the muscle cone. The third cranial nerve usually divides into its upper and lower

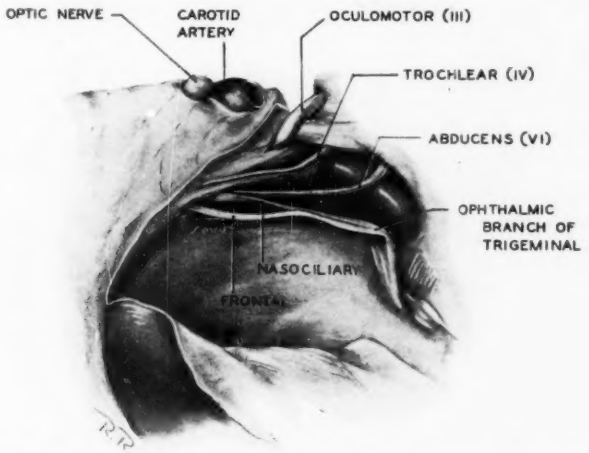

Fig. 2.—The lateral wall of the cavernous sinus has been reflected, showing the nerves as they enter the left superior orbital (sphenoidal) fissure.

branches well back in the cavernous sinus, opposite the ascending curve of the carotid artery. The upper branch enters the superior orbital (sphenoidal) fissure through the lateral edge of the tendon of the superior rectus and levator muscles. It curves on top of the optic nerve and enters the muscle just inside the zonule. The lower branch is much larger. It enters the orbit through the superior orbital fissure just lateral to the optic nerve by curving over the tendinous upper edge of the lateral

10. Duke-Elder,[9] p. 189. Kronfeld, P. C.: The Human Eye in Anatomical Transparencies, Chicago, Bausch & Lomb Company, 1943, p. 62. Rea, R. L.: Neuro-Ophthalmology, St. Louis, C. V. Mosby Company, 1938, pp. 39-41. Walsh, F. B.: Clinical Neuro-Ophthalmology, Baltimore, Williams & Wilkins Company, 1947, pp. 95-127.

rectus muscle. Two distinct heads to this muscle were not observed. The upper edge forms a horizontal tendinous band, over which the lower branch of the third cranial nerve passes. This branch curves under the optic nerve and divides immediately into the branch to the medial rectus muscle and the branch to the inferior rectus and inferior oblique muscles. The motor root to the ciliary ganglion is short and is given off just after the branch to the medial rectus muscle. The ciliary ganglion lies on the lower branch of the third cranial nerve, just lateral to, and slightly below, the optic nerve. The sixth cranial nerve lies just below, and slightly lateral to, the lower branch of the third cranial nerve as it curves over the tendon of the external rectus

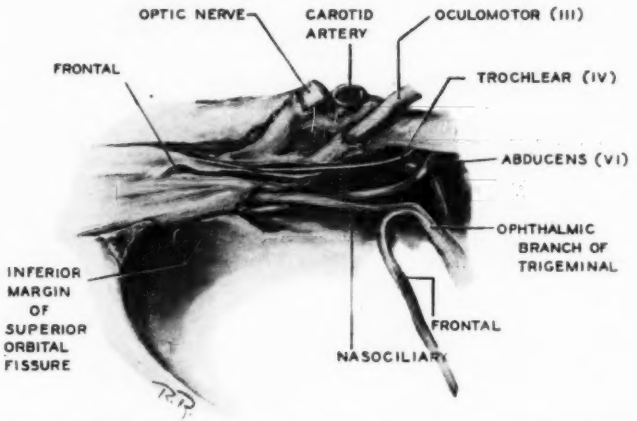

Fig. 3.—The bone over the optic canal, the superior orbital (sphenoidal) fissure and the roof of the orbit have been removed, showing the nerves as they enter the periosteum of the orbit.

muscle. It runs along the inner surface of the muscle for 1.5 to 2 cm. before entering the latter. The nasociliary branch of the fifth cranial nerve is the farthest lateral. It enters the orbit just lateral to the lower branch of the third nerve, passing over the tendon of the external rectus muscle. This tendon is a constant landmark. The sixth cranial nerve, the nasociliary nerve and the lower branch of the third cranial nerve were always found close together as they passed over this tendon to enter the orbit. This region, therefore, is the ideal place at which to block these nerves. The upper branch of the third nerve was considerably higher, about 3 mm., and ran along the top of the optic nerve. In order to block this branch from inside the muscle cone, one must place the needle slightly higher. If this region of the orbit is to be reached, a needle at least 5 cm. in length must be used.

In order to determine what happened to the solution when it was injected this far posteriorly, injections of methylene blue were made in 3 stillborn fetuses. In these fetuses there was no circulation of blood, and the dissection was made several hours after the injection. The dye was observed to be fairly well retained inside the muscle cone and to have come forward, staining the sclera as far forward as the insertions of the rectus muscles. The dye was not found posterior to the sphenoidal fissure, but the optic nerve in the orbit was stained completely in two injections.

In 1 case studied post mortem, 70 per cent iodopyracet U. S. P. ("diodrast") was injected shortly after death, and roentgenograms were

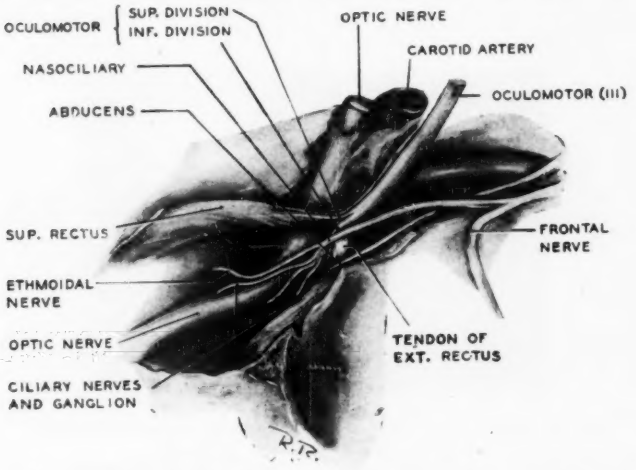

Fig. 4.—The periosteum of the orbit has been removed and the zonular ligament split just lateral to the tendon of the levator and superior rectus muscles. These muscles are cut anteriorly and turned back, showing the lower branch of the third cranial nerve, the sixth nerve and the nasociliary branch of the trigeminal nerve as they cross over the upper edge of the tendon of the external rectus muscle

taken of the skull (fig. 5). The material was found to come well forward behind the globe. It was retained in the muscle cone, some of the material possibly going back into the middle fossa.

It was difficult to set up a standard for the percentage of effectiveness of the anesthesia. This was estimated only roughly, depending on the patient's reaction when the iris was picked up. The conjunctiva at a distance from the limbus was not affected by blocking the nasociliary nerve; it had, therefore, to be anesthetized with local instillation or infiltration.

With the anesthetic effect produced by blocking the nasociliary nerve, there are rather prompt dilatation of the pupil, deepening of the anterior chamber and lowering of the intraocular tension. For the round pupil extraction of cataract, the pupillary effect is desirable, but it must be remembered that physostigmine does not control the denervated pupil. Pilocarpine nitrate, 1 per cent, instilled before operation, produces a small pupil in spite of complete sensory and motor block. Pilocarpine should be used after operation to produce prompt miosis. This was pointed out by Dr. Harold Scheie in a recent paper read before the American Ophthalmological Society.

The effect of the motor block was graded on a percentage basis, 20 per cent being deducted for each rectus muscle still functioning and 10 per cent for each oblique muscle still active. For example, if the

Fig. 5.—Deep injection of 70 per cent iodopyracet U. S. P. ("diodrast").

eye rotated only laterally, the motor block was considered to be 80 per cent effective. If two muscles were still active, the block was considered to be 60 per cent effective. If movement was good in all directions but one, the motor block was said to be only 20 per cent effective. There were also slight gradations for partial function.

It can be seen (fig. 6) that anesthesia of the globe was nearly perfect in 90 per cent of the cases but only fairly good in 10 per cent. This graph also shows that as yet it is not possible to obtain 100 per cent motor block by a single injection in every case. In 74 per cent of the cases better than 60 per cent motor block was obtained. The type of solution used and the method of injection produced only minor differences in the results. Figure 7 shows that with use of 4 per cent procaine hydrochloride the number of poor motor blocks is decreased and the number of good blocks slightly increased. This graph also shows that with a single injection below there was poor motor block in fewer cases and a good motor block in slightly more cases.

In the cataract operations it was possible to set up a standard for posterior segment pressure, or vitreous pressure, as I have called it. After the section is made with a Graefe knife, the lens and the diaphragm of the iris move forward in the majority of cases, just filling the anterior chamber. This pressure was recorded as normal vitreous pressure. If the movement forward was sufficient to cause gaping of the wound, prolapse of the iris or a horizontal wrinkle in the cornea, it was considered evidence of positive vitreous pressure. If the cornea collapsed, or if the diaphragm of the iris did not move forward to fill the anterior chamber and an air bubble filled the chamber spontaneously, this was considered evidence of negative vitreous pressure.

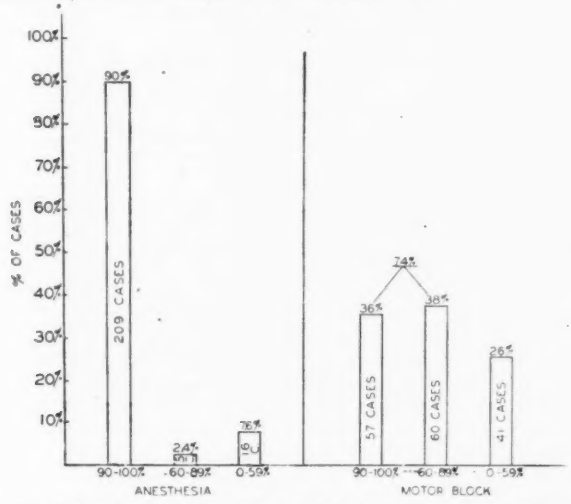

Fig. 6.—Estimation of deep orbital injection in terms of distribution of percentages of motor block (in 158 cases) and of anesthesia (in 230 cases).

Figure 8 demonstrates that when the motor block was good the vitreous pressure tended to be normal, or negative. When the motor block was poor, the vitreous pressure tended to be positive, with more cases of loss of vitreous in this group. The average effectiveness of motor block was only 45 per cent in the cases of positive vitreous pressure, 68 per cent in the cases of normal vitreous pressure and 78 per cent in the cases of negative vitreous pressure.

The method I am using at present is similar to O'Brien's [11] except that the needle is 5 cm. long (Becton and Dickinson, no. 25). It is

11. O'Brien, C. S.: Local Anesthetics in Ophthalmic Surgery, Tr. Sect. Ophth., A. M. A., 1929, p. 237.

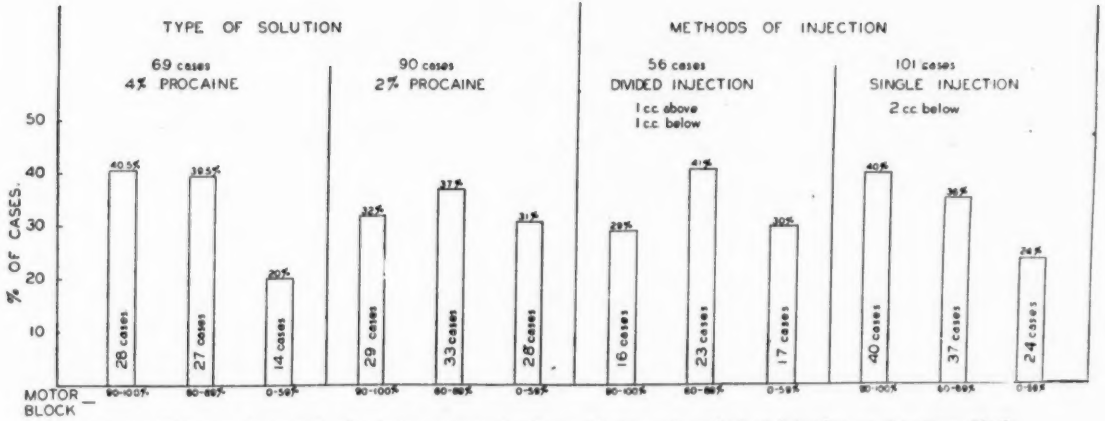

Fig. 7.—Relation of strength of solution of procaine hydrochloride and method of injection on the motor block.

inserted through the skin just inside the lower temporal rim of the orbit. It is then directed toward the apex of the orbit so that it will go through Tenon's capsule midway between the lower edge of the external rectus and the lateral edge of the inferior rectus muscle. Tenon's capsule can usually be felt; and if the patient has the eye rotated upward, the pressure of the needle passing through the fascia will pull the eye down. A quick, short thrust when this is seen or resistance is felt places the needle inside the muscle cone. From here the needle is simply "floated" back, with the aim the upper lateral corner of the orbit. If any obstruction is felt, the direction is changed slightly,

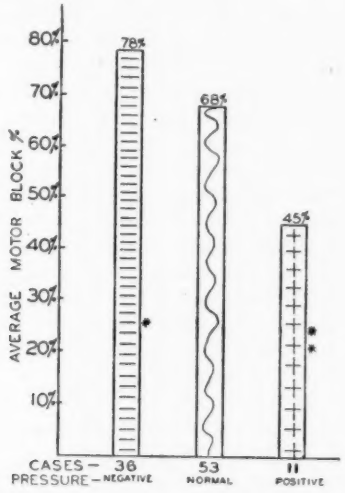

Fig. 8.—Relation of motor block to vitreous pressure in 100 cases. The asterisk indicates loss of vitreous.

either downward or more medially, until the needle can again be advanced. No force is used at any time after Tenon's capsule has been passed. The tip of the needle is kept lateral and high, following the lateral wall or the roof of the orbit until the full 5 cm. is reached. This procedure is like sliding a pencil into the apex of a funnel. When the orbital walls or the under surface of the muscle is touched, the patient may feel a deep, sharp pain. When the deepest point has been reached, 0.5 cc. is injected. With the needle still in place, the patient is now asked to move the eyes up and down, right and left, and the movements of the eye and lid are observed. If there is a slight ptosis, or if the eye does not move upward as well as the other eye, one can be quite sure that the superior branch of the oculomotor

nerve has been blocked. If, after a minute or two the superior rectus muscle is still functioning, the second 0.5 cc. of the solution is injected in the same place. The needle is now withdrawn slightly, 3 to 5 mm., the tip lowered about 4 mm. and the needle again pushed gently back to the full 5 cm. This should put the tip of the needle just below the optic nerve, in the region of the lower branch of the oculomotor nerve, the nasociliary branch and the sixth nerve. The second 1 cc. can now be injected, with a good chance of blocking all three of these nerves. The last cubic centimeter may be divided into two parts, the last 0.5 cc. being placed slightly lower still, or slightly more lateral if the lateral rectus muscle is still functioning.

I have called this method the "floating" technic, since at no time is any force used. The plunger of the syringe should be withdrawn slightly before injection each time that the position of the needle tip has been changed. If the needle cannot be floated in the full 5 cm., it should not be forced. The one venous hemorrhage I have had was caused by trying to force the needle in too deep. I could feel it perforate something, most probably the inferior orbital vein. My partner had one orbital hemorrhage, and I have had a second one recently.

There is, undoubtedly, slightly more chance of producing hemorrhage in the orbit with this deep multiple injection, but such a complication means merely postponing the operation. A massive loss of vitreous usually means the loss of the eye. I have not seen a massive loss of vitreous since using this deep orbital technic, in spite of the fact that the motor block was good in only 75 per cent of the cases. A poor motor block and a strong protective reflex have not yet come together in the same patient.

The optic nerve could be injured with a 5 cm. needle, as pointed out by Löwenstein [12] and Duverger.[13] I have not seen any clinical evidence of such injury in my cases. Vision and visual fields for finger motion were always as good as the state of the eye permitted. The nerve sheath appears to protect the optic nerve from the procaine, bathing it. Enough force actually to puncture the nerve is never used.

No local toxic effect in the orbit was seen when 2 per cent procaine hydrochloride was used. With either intracaine hydrochloride (β-diethylaminoethyl-p-ethoxybenzoate hydrochloride) or 4 per cent procaine hydrochloride, I observed some orbital reaction in a few cases. Occasionally there is slight immediate engorgement of the conjunctival vessels. This may be due to pressure on the venous channels in the posterior orbit. I am not sure about this, since it was seen only a

12. Löwenstein, A.: Ueber regionaire Anesthesia in der Orbita, Klin. Monatsbl. f. Augenh. **46**:592-607, 1908.

13. Duverger, C.: L'anesthesia locale en ophthalmologie, Paris, Masson & Cie, 1920.

few times and caused no trouble during the operation. In a patient given an injection preparatory to operation for acute glaucoma, there developed generalized tremors with rapid pulse and respiration, lasting about three minutes. In this case the procaine may have been injected into a venous sinus.

The advantage of being able to operate on an eye which cannot be moved by the patient and which is insensitive to pain is so great that these possible dangers are overshadowed. In cataract surgery, the reduction in the vitreous pressure reduces the loss of vitreous to a minimum. The lowering of intraocular tension has been pointed out as an objectionable feature of retrobulbar anesthesia when used in cataract surgery. Atkinson [14] and others expressed the belief that this softening of the globe makes the extraction more difficult. In my opinion this feature is highly desirable. If the eye is soft, the surgeon can always increase the posterior segment pressure merely by using more pressure. He can control this pressure. If, however, the vitreous pressure is positive, the surgeon is at the mercy of the patient, who is in no position to do anything about it. In glaucoma surgery, the lowered tension at the time of the operation is certainly a factor of safety worth having. This type of anesthesia and motor block makes painless enucleation of even the most inflamed eye. The muscles may be pulled or stretched without pain. The muscles do not retract, making it easier to suture them around an ordinary implant or one of the Cutler type. For the same reason, operations for strabismus may be done without pain. A better estimation of the amount of fibrosis is possible when the muscle is completely relaxed. In operations for retinal detachment, relaxation of the muscles makes it much easier to work around and under them. It is seldom necessary to detach a muscle, and the operation is really painless. The blocking of any afferent pain stimulus or axon reflex, is, I believe, an important factor in producing less postoperative reaction.

CONCLUSIONS

An attempt has been made to extend the usefulness of retrobulbar anesthesia by producing a motor block of the extraocular muscles. The use of a 5 cm. needle "floated" into the apex of the orbit from below and laterally has not proved dangerous. I have experienced orbital hemorrhage in only 2 cases, and this caused no damage to the eye.

Using 2 cc. of 2 or 4 per cent procaine hydrochloride, with 0.4 cc. of epinephrine hydrochloride to the ounce (29 cc.), I was able to produce a better than 60 per cent motor block in 74 per cent of 158 cases.

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14. Atkinson, W. S.: Local Anesthesia in Ophthalmology, Arch. Ophth. **30**: 777-808 (Dec.) 1943.

The posterior segment, or vitreous, pressure was found to be considerably lower when this motor block was good.

Of 100 cases of intracapsular cataract extraction, vitreous was lost in only 1, in which the motor block was good, and in 2 others, in which the motor block was 20 per cent or less, a percentage loss of 3.

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ABSTRACT OF DISCUSSION

DR. GARRETT L. SULLIVAN, Boston: In my experience with military and civilian surgery, I have found two factors of importance in achieving effective local anesthesia and akinesia. The first is adequate preoperative medication. A calm, relaxed patient may spell the difference between success and failure, especially in cataract surgery.

The second important consideration is that the surgeon be patient and allow time for full effect of the anesthetic to develop. The first sensation of pain is sufficient stimulus to set the patient in a state of apprehensive anticipation of more to come. The surgeon who can bide his time for at least ten minutes after injection will usually be rewarded with more efficient anesthesia and akinesia.

As measured by Dr. Gifford's standard, I have observed 90 per cent motor block following the retrobulbar injection of 1 cc. of 4 per cent procaine hydrochloride, using a 3.5 cm. needle. This suggests that as good an effect can be obtained with a needle 1.5 cm. shorter than that recommended by Dr. Gifford. I should like to ask whether he can tell us what happens to the solution of the retrobulbar injection within the muscle cone when a 3.5 cm. needle is used? Is it not reasonable to assume that, given time, the procaine will find its way to the apex of the muscle cone? His percentage effectiveness of motor block following deep orbital injection is good. I suggest that a comparative study be made of his results and those of retrobulbar injection when a 3.5 cm. needle is used.

The danger of orbital hemorrhage with deep orbital injection seems to be greater, since the point of the needle would be in an area where vessels are larger and more fixed in position. The possibility of injecting the local anesthetic into the circulating blood would, likewise, be greater. I have seen orbital hemorrhages result from retrobulbar injection in 2 cases; like Dr. Gifford, I found that they caused simply postponement of the operation. The "floating" technic described by Dr. Gifford has apparently been safe in his hands. He has stated that there is little, if any, danger of penetrating the sheath of the optic nerve. Has he tried to inject the optic nerve of cadavers? One wonders how much pressure is required to penetrate the sheath of the optic nerve.

Because of the possibility of retrobulbar hemorrhage, some surgeons elect to inject procaine under the four rectus muscles. There is undoubted merit in this procedure; theoretically, it should yield an 80 per cent motor block, as well as effective anesthesia.

As pointed out by Dr. Gifford, the tonicity of the extraocular muscles plays a significant role in loss of vitreous, and his statistics demonstrate that the more effective the motor block, the lower the incidence of this complication. However, it should be emphasized that the tonus of the extraocular muscles is by no means the sole cause of

loss of vitreous. Inadvertent pressure on the speculum by the surgeon or his assistant may cause rupture of the hyaloid membrane and resultant escape of vitreous. More commonly, inadequate akinesia of the orbicularis oculi provides an opportunity for the patient to squeeze his lids, pressing the speculum on the globe and ultimately causing rupture of the hyaloid membrane.

Dr. Gifford has proposed a concept of vitreous pressure, suggesting as a factor an inherent pressure within the vitreous body. Such a concept may be applied to certain types of glaucoma in which there is an actual increase in the volume of the vitreous. In non-glaucomatous cataractous eyes, however, it seems that the cause of escape of vitreous from the eye always lies in pressure on the scleral covering. It may be that basically his concept is consistent with this idea; if this is so, the term vitreous pressure may not be most appropriate.

At the Massachusetts Eye and Ear Infirmary, 4 per cent procaine hydrochloride has been used for several years in all operations on the eye. The chief value of this strong solution probably lies in the fact that more rapid anesthesia and akinesia can be obtained with a smaller amount of the anesthetic. The 2 per cent solution would undoubtedly be equally as effective if sufficient time were allowed for it to act. Although it is generally recognized that systemic toxicity may result from the use of procaine, I know of no occurrence during these years of either local or general toxicity, and I question Dr. Gifford's reference to the local toxic effects of the 4 per cent solution. It is quite likely that pressure caused the venous engorgement observed.

Some surgeons believe that the lowered intraocular pressure resulting from retrobulbar anesthesia is undesirable, especially in cataract operations. I agree with Dr. Gifford that the advantages of lowered pressure outweigh the objectionable features. Extraction of the cataract may take somewhat longer, but patience and perseverance will usually result in an uncomplicated removal of the lens. I cannot, however, agree with his statement that the surgeon is able to control the pressure at will. Such a statement presupposes knowledge of how much pressure the hyaloid membrane will tolerate. Obviously, the surgeon can exert only that amount of pressure which his own judgment and experience dictate to be safe. The result in the individual case will prove his judgment to have been correct or incorrect.

DR. EDWARD BURCH, St. Paul: Despite the objection of a few ophthalmic surgeons to the employment of retrobulbar injection of local anesthetic agents, principally procaine, it is clearly the consensus that such a procedure as a routine preoperative measure constitutes one of the most worth while advances in local anesthesia of the eye in recent years. This is believed to be particularly true with respect to the extraction of cataractous lenses, the surgical relief of increased intraocular tension and the repair of retinal detachments.

Any innovation or new technic in the injection of local anesthetics into the muscle cone therefore deserves careful consideration. The widespread acceptance of any new method, such as the one which Dr. Gifford has outlined, will largely depend on four factors: (1) whether it is a safe procedure, (2) whether it is effective, (3) whether it can be executed without undue difficulty and (4) whether it confers distinct advantages over procedures now in vogue.

What elements of hazard may be recognized in deep orbital injection? The danger of introducing pathogenic bacteria into the orbit, of course, must be mentioned, but if the principles of asepsis are observed the risk on this score is remote. Furthermore, if infection should become established, highly potent chemotherapeutic and antibiotic agents are readily available. The danger of infection cannot, therefore, be regarded as a serious objection. Of greater significance is the possibility of inflicting damage with the needle on important structures, particularly the optic nerve and the blood vessels behind the eye. Although the orbital segment of the optic nerve is invested with a tough dural covering, it is theoretically possible, as Dr. Gifford has shown in his anatomic studies, for the 5 cm. needle to impinge on the nerve. Unquestionably, penetration of the nerve sheath would result in a grave complication, which cannot be lightly disregarded. Hemorrhage behind the eye is another risk which accompanies any deep orbital injection. In Dr. Gifford's series, 1 case of such a hemorrhage was encountered, while it occurred in another case during an injection performed by his associate. During the past fifteen years I have seen but 2 retrobulbar hemorrhages when Atkinson's technic of injection of the muscle cone with a 3.5 cm. needle was employed. Hemorrhage following orbital injection is not ordinarily a serious matter and requires merely the postponement of operation for a few days. The possibility that the tip of the needle will break off because of a violent movement of the patient comes to mind. If new stainless steel needles of good quality are used, the patient has received adequate preoperative sedation and the use of force in introducing the needle is sedulously avoided, as Dr. Gifford has counseled, the danger of this complication is remote.

In addition to the hazards involved, one should consider the reaction of the patient to the pain and discomfort entailed by the injection. If the needle is introduced into the orbit through a previously prepared intradermal wheal, no appreciable pain is experienced by the patient as the needle pierces the skin. It is my impression, however, that, once the needle traverses the orbital fascia and penetrates deep into the orbit, greater pain is elicited with a long, 5 cm., needle than when the conventional muscle cone injection with the shorter, 3.5 cm., needle is used. At least such has been the case in my admittedly brief experience. Perhaps with greater practice, it will be possible to effect the deep injection with less discomfort to the patient.

Dr. Gifford's data are ample evidence that his technic will produce motor block and decreased posterior segment pressure in a satisfactorily high percentage of cases. In the few cases in which I have employed Dr. Gifford's technic I have found that the eye was in excellent position for operation after the injection and that the decrease in vitreous pressure was gratifying. It might be of interest to undertake a comparative study of the results of Dr. Gifford's technic and those of conventional muscle cone injection, employing the criterion for muscle block which he suggested. I should like to inquire whether Dr. Gifford has made any such comparison of the two procedures.

With regard to the negative pressure which follows section of the globe when retrobulbar injections have been made, one point deserves comment. Occasionally, if the negative pressure is pronounced, and an attempt at intracapsular extraction is unsuccessful, owing to rupture of the capsule, some difficulty in expressing the lens may be encountered.

I wonder whether Dr. Gifford would be willing to express an opinion as to whether the hypotony produced by his technic is more profound than that with the conventional injection, especially if greater amounts of procaine-epinephrine solution are used. Ophthalmic surgeons who perform the extracapsular operation routinely might find the more extreme degrees of decreased pressure a source of embarrassment if this is the case.

I am of the opinion that if the operator possesses a sound knowledge of the anatomy of the orbit and is accustomed to making retrobulbar injections, no undue difficulty will be experienced and the technic can be successfully mastered.

Dr. Gifford's method of deep orbital injection involves slightly greater risk than the orthodox injection of the muscle cone, but, on the basis of the evidence he has presented, produces a more effective motor block and results in a higher incidence of normal or negative vitreous pressure than does the older technic. It probably entails somewhat greater discomfort to the patient in its execution and is slightly more difficult to carry out properly. Its greater effectiveness, however, particularly in cataract surgery, is distinctly a point in its favor.

Dr. Purman Dorman, Seattle: Owing to rules of the Section regulating the time allowed for presentations, Dr. Gifford was unable to include in his paper some of his points for later discussion or to give his motion picture. I should like to have my own discussion time devoted to the presentation of the motion picture.

Dr. Everett L. Goar, Houston, Texas: No one has mentioned the fact that if a retrobulbar injection is properly made orbital hemorrhage will not occur. It is necessary continuously to inject the solution ahead of the needle tip as it passes through orbital tissue. I have made hundreds of such injections and since adopting that method have never had a hemorrhage. However, I have never used a needle longer than 3.5 cm.

Dr. Harold Gifford Jr., Omaha: I have presented this paper with misgivings, for I know that this procedure is a little more dangerous than the older ones. Undoubtedly, there is more danger of orbital hemorrhage with the longer needle; however, I had used a 3.5 cm. needle for years and could never get much, if any, motor paralysis. With the 5 cm. needle we have been trying to produce akinesia and anesthesia and avoid loss of vitreous. We are getting closer to our goal; we are not there yet, but I know that we have prevented loss of vitreous in many cases. In fact, only 3 cases in 100 is not a bad showing.

(A short motion picture was shown to demonstrate the technic of deep orbital injection.)

The reasons for failure are twofold. Some orbits are too long; one cannot get back far enough. In persons with fat faces and fatty tissue in the orbits, the procaine does not have the effect that it has in thin people. I am sure the reason has something to do with the consistency of the fat in the orbit. I believe that if the surgeon will use this method he will be much happier in doing cataract extractions. It gives one a wonderful feeling of relaxation to know that the eye will stay where it is and that vitreous is not going to be squeezed out.

RESPONSES TO THE ISHIHARA TEST FOR COLOR PERCEPTION

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SEVERAL tests have been devised to detect abnormalities of color perception. The easiest, and the most convenient for mass examination, are those using the pseudoisochromatic plates, of which the Ishihara test is one. Owing to the ease with which it can be made, this test has been used frequently to determine the incidence of defective color vision in various groups of people. We are not aware of any such study having been made among Filipinos.

METHOD AND MATERIAL

This study was conducted on students seeking admission to the University of the Philippines. In order to avoid their faking results, it was made clear that the results of the test would have nothing to do with their admission to the university. The 16 plate edition of the Ishihara test book, printed in Tokyo, Japan, in 1932, was used. The plates were numbered consecutively from 1 to 13 (the last 3 plates, for illiterates, were not used) and were placed about 60 inches (150 cm.) from the subject in an open hall with indirect sunlight. The subject was asked to write down the digit he saw in each plate with his two eyes. Those who hesitated, who read with difficulty or who misread or otherwise saw digits other than those supposed to be seen by persons with normal color perception were retested at a distance of 30 inches (90 cm.). The subjects reexamined were often asked to trace the figures they claimed to have seen. A response other than that stated for normal persons in the key for each plate was considered an error or a miss.

RESULTS

A total of 959 male and 977 female subjects were tested. The distribution of the subjects according to total errors scored and the plates on which the errors were made are shown in tables 1 and 2. Of the male subjects, 43.2 per cent made perfect scores, that is, without a single miss. An equally large number made 2 mistakes, mostly on plates 10 and 11. It was surprising how large was this group of subjects who saw, though with difficulty, the hidden figures in these plates alone without failing on the other plates. The hidden digits are visible

From the University of the Philippines College of Medicine.

to normal persons [1] more frequently under daylight than under tungsten illumination.[2] Deuteranopic and deuteranomalous subjects are less likely to see the hidden figures under tungsten light than under average daylight. Our illumination probably had a color temperature between that of average daylight and that of tungsten light. We wonder whether the type of illumination we used, fading of the plates or persistence of the subjects in looking for the hidden figures was partly responsible for the large number of subjects discerning the digits. It is interesting to note, however, that all subjects who scored 2 errors or more saw

TABLE 1.—*Distribution of Male Subjects According to Errors Made*

(a) Errors Scored by Each Subject	(b) No. of Subjects	(c) (b) × 100 Total No. of Male Subjects (%)	Male Subjects Who Misread (Expressed in Percentages of Column b)											
			Plate 2	Plate 3	Plate 4	Plate 5	Plate 6	Plate 7	Plate 8	Plate 9	Plate 10	Plate 11	Plate 12	Plate 13
0	415	43.2	...	...	...	...	...	...	...	...	...	...	...	...
1	47	4.9	2	...	2	4	...	...	...	...	55	36	...	...
2	450	46.9	...	...	...	1	...	...	...	...	99	99	...	...
3	6	0.6	...	...	...	50	...	...	17	33	100	100	...	...
4	1	0.1	...	...	...	...	...	...	100	100	100	100	...	...
6	2	0.2	50	50	100	...	...	...	100	50	100	100	50	...
7	1	0.1	...	...	100	...	100	100	100	100	100	100	...	...
8	3	0.3	67	...	33	100	...	100	100	100	100	67	67	67
9	2	0.2	...	50	100	100	100	100	100	100	100	100	50	...
10	2	0.2	...	...	100	100	100	100	100	100	100	100	100	100
11	5	0.5	100	60	100	100	100	80	100	100	100	100	100	60
12	25	2.6	100	100	100	100	100	100	100	100	100	100	100	100
Total	959	99.8												
Male subjects who misread each plate (expressed in percentage of total no. of male subjects who made mistakes)			6.3	5.5	7.2	8.7	6.4	6.8	7.7	7.7	95.7	93.7	6.6	5.9
Male subjects who misread each plate (expressed in percentage of total no. of male subjects)			3.5	3.0	4.1	4.8	3.7	3.9	4.4	4.4	54.3	53.2	3.8	3.3

the hidden digits in either or both plates. Judging from the percentage of the subjects who failed on plates 10 and 11, it would seem that these plates might give misleading values regarding the incidence of persons with defective color vision. We are in agreement with the statement of Hardy, Rand and Rittler [3] that this series of plates is the

1. Collins, M.: Tests in Common Use for the Diagnosis of Colour Defect, Nature, London **140**:569, 1937.

2. Hardy, L. H.; Rand, G., and Rittler, M. C.: Effect of Quality of Illumination on Results of the Ishihara Test, Arch. Ophth. **36**:685 (Dec.) 1946.

3. Hardy, L. H.; Rand, G., and Rittler, M. C.: Tests for Detection and Analysis of Color Blindness: II. Comparison of Editions of the Ishihara Test, Arch. Ophth. **35**:109 (Feb.) 1946.

least satisfactory in the Ishihara test because a considerable number of persons having normal color vision see the hidden digit, thus failing the plate.

Disregarding, therefore, the results in plates 10 and 11 and using Miles's criterion [4] for designating a subject as having defective color vision (that is, a subject has defective color vision when he makes 2 or more out of a possible 10 errors), we obtain 4.3 per cent as our incidence of defective color vision. On the basis of Hardy, Rand and Rittler's observations that no subject with low normal color vision scores less than 75 per cent,[5] or makes 4 or more errors out of a possible 12, we computed and obtained the same incidence of defective color vision,

TABLE 2.—*Distribution of Female Subjects According to Errors Made*

(a) Errors Scored by Each Subject	(b) No. of Subjects	(c) (b) × 100 / Total No. of Female Subjects (%)	Female Subjects Who Misread (Expressed in Percentages of Column b)											
			Plate 2	Plate 3	Plate 4	Plate 5	Plate 6	Plate 7	Plate 8	Plate 9	Plate 10	Plate 11	Plate 12	Plate 13
0	540	55.3	....	....	....	....	....	....	....	....	....	....	....	....
1	81	8.2	....	....	....	8.6	....	....	....	....	69.1	21.0	1.2	....
2	351	36.0	....	....	....	1.1	....	....	....	0.3	99.7	98.8	....	....
3	3	0.3	....	....	....	100.0	....	....	....	....	100.0	100.0	....	....
7	1	0.1	100.0	....	100.0	100.0	....	....	100.0	100.0	100.0	100.0	....	....
12	1	0.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total	977	100.0												
Female subjects who misread each plate (expressed in percentage of total no. of females who made mistakes)			0.5	0.2	0.5	3.4	0.2	0.2	0.5	0.7	94.0	84.4	0.5	0.2
Female subjects who misread each plate (expressed in percentage of total no. of female subjects)			0.2	0.1	0.2	1.6	0.1	0.1	0.2	0.3	42.1	37.8	0.2	0.1

namely, 4.3 per cent. This is close to the 4.1 per cent of male subjects who failed in plate 4, the plate considered by the latter group of workers as ideal for screening persons with defective color vision. Inasmuch as the lighting used in the present study probably did not reach the color temperature of average daylight, as advocated for use in this test,[6] some persons with deficient color vision must have escaped detection.

4. Miles, W.: One Hundred Cases of Color Blindness Detected with the Ishihara Test, J. Gen. Psychol. **2**:535, 1929.

5. Hardy, L. H.; Rand, G., and Rittler, M. C.: Tests for Detection and Analysis of Color Blindness: I. An Evaluation of the Ishihara Test, Arch. Ophth. **34**:295 (Oct.) 1945.

6. Hardy, L. H.; Rand, G., and Rittler, M. C.: The Ishihara Test as a Means of Detecting and Analyzing Defective Color Vision, J. Gen. Psychol. **36**: 79, 1947; footnotes 2 and 5.

Consequently, the values cited are probably lower than those which would be obtained if average daylight illumination had been used.

Comparing our data with similar studies on other racial groups,[7] we find that the incidence of defective color vision among Filipinos is less than that among unselected white persons or Chinese, but is higher than that among Mexicans, full-blooded Indians and American Negroes.

Of the 36 subjects who made mistakes in plates 12 and/or 13, only 17 were "classified" by the "hit and miss" criterion of Hardy, Rand and Rittler. All the 17 read correctly only the first digit of either or both of these plates, missing or not seeing the red-purple digits. Of the 17, 7 were "classified" by plate 12, 1 by plate 13 and 9 by plates 12 and 13. The classification of these subjects as deuteranomalous or deuteranopic must be made with caution, however, in view of the uncertainty about the color temperature of our illumination.

Of female subjects, only 0.3 per cent had defective color vision (by Miles's criterion), or 0.2 per cent by the criterion of Hardy, Rand and Rittler. Plate 4, in table 2, gave an incidence of 0.2 per cent.

SUMMARY

Approximately 2,000 male and female subjects were tested with the Ishihara color plates. Tables are presented showing the percentage of subjects failing on each individual plate and grouping them according to the total number of errors made.

The incidence of male subjects with defective color vision as determined by Miles's criterion, or by Hardy, Rand and Rittler's criterion, which was 4.3 per cent, was almost the same as the incidence of subjects who failed in plate 4, which was 4.1 per cent. For female subjects the two criteria gave 0.3 and 0.2 per cent, respectively, while plate 4 gave an incidence of 0.2 per cent.

A large number of subjects saw the hidden digits in plates 10 and 11 without misreading other plates. Many in this group probably have normal color vision.

In view of what has been found regarding the effect of different types of illumination on the results of the Ishihara test, the values reported here are probably lower than those which would be obtained if "average daylight" illumination had been used.

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7. Clements, F.: Comparative Racial Differences in Color Blindness, Science **72**:203, 1930. Garth, T. R.: Incidence of Color Blindness Among Races, ibid. **77**:333, 1933. Shuey, A.: Incidence of Color Blindness Among Jewish Males, ibid. **84**:228, 1936. Kilborn, L. G., and Beh, Y. T.: The Incidence of Color-Blindness Among Chinese, ibid. **79**:34, 1934. Crooks, K. B. M.: On the Incidence of Color-Blindness Among Negroes, ibid. **80**:269, 1934.

INTERSTITIAL KERATITIS AND VESTIBULOAUDITORY SYMPTOMS FOLLOWING VACCINATION

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THE report by Cogan [1] of the syndrome of nonsyphilitic interstitial keratitis and vestibuloauditory symptoms, in which the matter of etiology was permitted to remain unsolved, has stimulated interest in this subject. Because of the rarity of diagnosis of this syndrome and because of a suggested etiologic factor in the case to be reported, this paper is submitted as an introductory study of postvaccinial encephalitis.

REPORT OF A CASE

A man aged 30, who had served in the armed forces for slightly over four years, had onset of the acute episode of his illness on March 13, 1945, one hour after the noonday meal, which consisted of pork, vegetables, bread, butter, coffee and canned fruit. The initial symptom was nausea, which was followed shortly by retching and then by vomiting of projectile character. After the vomiting had ceased, the patient noticed a persistent dull nuchal ache, which did not keep him from his work, although it remained unchanged throughout the rest of the afternoon. There was no chill, dizziness or fever at this time. The patient slept well that night; but on his awakening the next morning he was aware of a rather severe dizziness, in which the bed seemed to turn about in circles. The dizziness vanished sufficiently in a few hours so that he was able to report to work at the usual time. Again, after the noonday meal, which he ate sparingly, the symptoms of the previous day recurred, together with an oppressive tightness about the neck. The acute dizziness recurred, and the patient returned to his quarters, where he spent a quiet and comfortable night. On the second day there was no recurrence of the headache. On arising on March 15, the patient was still acutely dizzy and somewhat faint. He was admitted via ambulance to the hospital, where, after a mild bout of retching, the only obvious symptom during the first week was persistence of the dizziness, which was more pronounced when the patient was erect. At no time was there any abnormality of temperature. His past history indicated that he had had several virus diseases, all of them mild. He had had several mild attacks of herpes labialis. Mumps, measles, scarlet fever and chickenpox had been contracted, all without any serious sequelae. He had never been hospitalized and had never been ill longer than three days. He had been told that he had mild sinusitis, and during the past three months he had had a cold and cough "on and off." No history of sensitivity to plants or to serums was forthcoming; the patient had had many "shots" during his military career, but none had been followed by disturbing symptoms; in fact, he seemed to suffer less local reaction after an injection than any of his companions.

1. Cogan, D.: Syndrome of Nonsyphilitic Interstitial Keratitis and Vestibuloauditory Symptoms, Arch. Ophth. **33**:144 (Feb.) 1945.

On March 6 the patient received vaccinia virus and was given a stimulating dose of typhoid and paratyphoid vaccine U. S. P. There was no systemic or local reaction to the vaccination or to the injection of typhoid vaccine, and the incident had been forgotten completely.

On his admission, the results of physical examination were reported to be entirely normal. The temperature was 98 F., the blood pressure 114 systolic and 86 diastolic, and the pulse rate 86 per minute. There were no positive neurologic signs and no physical findings of significance other than the acute vertigo. The urine was normal. A blood count performed on the day of admission showed a leukocytic count of 11,700, of which 72 per cent were polymorphonuclear cells and 28 per cent were reported as "lymphocytes." Several subsequent blood counts were performed, with a variation of 8,000 to 15,000 leukocytes and maintenance of the previous percentages for the differential count. The reactions to routine tests for syphilis, brucellosis and tularemia were reported as negative. No studies of the spinal fluid were made until ten days after the onset of the illness, at which time the following report was obtained: pressure normal; cell count 0; colloidal gold curve 00000; globulin not increased; total protein 22 mg. per hundred cubic centimeters; Wassermann reaction negative.

Roentgenograms of both the skull and the chest were reported as showing nothing abnormal. Because of the persistence of the vertigo without associated symptoms, otologic and neuropsychiatric consultation was sought. The neuropsychiatric consultation, held one week after the patient's admission, is recorded in its entirety because it prevents many interesting side lights.

"The neurologic status was normal. There was no nystagmus or ataxia. No abnormal reflexes were elicited. The cranial nerves were normal. The fundi were normal. The history and physical signs did not indicate an expanding intracranial lesion. The patient had been married about four years; no children had been born. He was a lawyer by formal training and had been a member of the bar in his home state for several years. After his induction into the Army, in February 1941, he took basic training and on its completion was assigned, by reason of his previous training, to a legal type of work in division headquarters.

"After several months at this type of work, he applied for officers' candidate school, from which he was eliminated after eleven weeks because of 'lack of leadership in combat.' He was given the opportunity of remaining as an enlisted man at the same camp headquarters, where he continued to work in several capacities requiring legal training, and eventually he was given his present rank of warrant officer. On returning from officially granted leave on Feb. 25, 1945, he learned that he had been relieved of his assignment and had been placed on an available list of men expecting orders for duty elsewhere, possibly overseas.

"For the previous three months he had been feeling generally weak, tired and exhausted. He had always been of a passive personality. He maintained a definite feeling of inadequacy because there had been no children in his marriage. His legal ambitions were of a passive type, and he admitted that he never pictured himself as a successful 'trial' lawyer. While at officers' candidate school, he found the physical program difficult to carry through, and on many occasions he was forced to 'fall out.'

"The patient appeared to be a passive, neurasthenic person. In the service he failed to gain a commission because of lack of physical performance and leadership of men in combat type of duty. After this failure he was given a form of work which was technically and psychologically acceptable to him. As a result of his work, he gained a warrant officer's status, which to him was very gratifying.

"While on leave, he was relieved of his command, without previously being informed, and placed on an 'available' list. Consciously, he took this in a normal manner and reacted with, 'Well, a soldier is never put.' Psychologically, however, he felt that it was a serious failure on his part. With this news there was the threat of combat duty and separation from his wife, on whom he depended a great deal emotionally. He reacted to the situation in the only manner of which he was capable, an acute episode of hysteria. His neurasthenic features had existed for many years and manifested themselves early in his military career. The diagnosis was psychoneurosis and neurasthenia."

Otolaryngologic consultations and studies were of indeterminate value. The patient's history revealed that two years earlier he had had an episode of buzzing in his ears following a period of diving. This buzzing had lasted only two days. As far as the patient could tell, the condition had entirely disappeared. One week after the onset of the acute vertigo the patient complained of auditory disturbances of transient character. He described these as of two distinct types: One was of the "cockleshell variety"; the other resembled the hum of an "undialed telephone." The otologist reported the results of his audiometric and labyrinthine studies as being unreliable, transitory, indeterminate and contrary to expectation. Three separate cold water tests were performed in the first two weeks, and in each the patient did not respond normally. Cutaneous douching for two minutes failed to bring on any of the normal signs of an active labyrinth, such as nystagmus, nausea, vomiting, vertigo or past pointing.

From the appearance of the audiogram, the deafness was regarded as a mixed, rather than a plain, type of nerve deafness.

During the patient's first week of hospitalization the only symptom from which he suffered was vertigo. This dizziness appeared to be improving at the end of two weeks. During the second week the transient auditory symptoms appeared. Ocular manifestations made their initial appearance about the first of April, being mild at the onset. The right eye was first involved. There was no pain or secretion. There were mild conjunctival injection and a slight sensitivity to light. After the instillation of a mild astringent (zinc sulfate, 0.25 per cent), the eye appeared to improve and remained comfortable for about ten days, at which time there was a recurrence of similar, but severer, symptoms. Examination at this time disclosed a very mild aqueous flare, increased thickening of the cornea, with several folds in Descemet's membrane, and many "craters" in the zone of specular reflection. Several small foci of increased corneal opacification were located in the stroma. At various places the limbal vessels were beginning to push into the corneal substance superficially. Under treatment with local instillation of atropine and intravenous administration of typhoid vaccine (a series of seven injections was given), the right eye gradually cleared within three weeks; but by this time a similar condition was developing in the left eye. Attacks continued to shift from one eye to the other, each lasting about one week and each clearing completely and leaving no sequela. The attacks appeared unrelated to any other systemic manifestation. During one phase, sulfathiazole was used systemically, without any apparent benefit other than to indicate that the patient was sensitive to that drug; in a subsequent interval penicillin therapy was instituted, with as unencouraging a response. Throughout the course of the ophthalmic illness, partly because of familiarity with the events leading up to the patient's hospitalization, together with the neuropsychiatric diagnosis and the presence of conjunctival secretion even when definite keratitis existed, it was difficult not to suspect malingering.

COMMENT

In 1904 Aldrich [2] stated:

> The variolus process possesses, in marked degree, the power to awaken latent predispositions to nervous disease, as well as to independently disorder function and create anatomical alterations in the various nervous structures of the body.

In order to explain this rare syndrome of involvement of the vestibuloauditory nerve associated with interstitial keratitis as a form of postvaccinial encephalitis, it is necessary to mention some clinical and much experimental evidence completely outside the scope and purpose of this paper. Some of the recently accumulated literature, however, serves to illustrate by analogy the mechanism which may have been at work in the production of this syndrome. The concatenation of events necessary to explain the entire picture, admittedly, is forged in weakness; there is no lack of realization of this fact. However, the clear-cut nature, rather than the rarity, of the syndrome offers some compensation.

Cogan [1] reported 4 cases of interstitial keratitis associated with vestibuloauditory symptoms. In many respects, the present case simulates those reported by Cogan. In Cogan's cases the cause was unknown and the disease had not run its full course at the time of the report. The transient and evanescent nature of the interstitial keratitis was stressed, but it was impossible to attach etiologic significance to any of the characteristics of the syndrome, although I must confess that when I first read the case reports I felt that there lurked an elusive and little understood virus as an etiologic possibility. Involvement of both divisions of the eighth nerve, together with a portion of the fifth nerve, and an acute cephalgic onset speak for a thoroughly localized cerebral syndrome. Can such a set of circumstances arise after a postvaccinial episode, much as in the postvaccinial encephalitides, with limited and specific localization of cranial nerves, particularly when the cutaneous response to the vaccine is entirely negative? If so, can a response be called forth at the end organs of these cranial nerves in a series of successive waves, gradually tapering off in its severity?

Cogan, in reporting the "syndrome of nonsyphilitic interstitial keratitis associated with vestibuloauditory symptoms," stated that the syndrome had been reported only once previously and the cause was unknown; consequently, the purpose of his reporting these cases was to stimulate further studies. Characteristics of the syndrome is the interstitial keratitis, associated with vertigo, tinnitus and deafness. After a review of Cogan's 4 cases and Mogan and Baumgartner's [3] case and the consideration of the present case, certain clinical features stand out

2. Aldrich, C. J.: Am. J. M. Sc. **127**:198, 1904.
3. Mogan, R. F., and Baumgartner, C. J.: West. J. Surg. **42**:628, 1934.

rather prominently: (1) repeated negative reactions to the Wassermann test and allied serologic studies of the patient, as well as of both parents; (2) bilaterality of both ocular and auditory symptoms; (3)occurrence in young adults; (4) chronicity, with multiple unpredictable recurrences; (5) close time relation between onset of ocular and of aural symptoms; (6) mildness of ocular symptoms; (7) aggravation of symptoms by changes in the weather; (8) striking variation in symptoms; (9) characteristic yellowish white corneal opacities, tending toward vascularization; (10) evidence of iritis, as determined by cells in the anterior chamber and occasional keratic precipitates; (11) leukocytosis and suggestive eosinophilia; (12) bilateral nerve deafness, and (13) constant condition of the cornea.

Cogan emphasized the definite difference between the picture of syphilitic interstitial keratitis and that of this syndrome, so that no difficulty in differentiation should be encountered. However, he could draw no conclusion as to the cause of this syndrome. Cogan also noted that during the year in which these 4 cases were observed he encountered only 1 case of active syphilitic interstitial keratitis in his practice. He cited Sagher[4] as authority for the statement that 84 per cent of patients with interstitial keratitis showed a positive serologic reaction or some definite stigma of congenital syphilis. Cogan expressed the opinion that the nonsyphilitic syndrome is commoner than Sagher's percentage incidence would indicate.

Review of the history in each of Cogan's cases did not suggest any etiologic factor similar to that in the present case. However, there were some unusual features in the past history in his cases 1, 3 and 4. In his first case, one of the patient's sisters died at 18 months of age during an influenza epidemic. The patient had a severe cold three months prior to the onset of the syndrome. In case 3 the patient had an attack of "ptomaine poisoning" just prior to the onset of her illness. In case 4 the patient had been exposed to lewisite (β-chlorovinyldichloroarsine) two years earlier, at which time there were temporary ocular symptoms. In a highly speculative manner, one may assume that case 1 represents a host which is unusually susceptible to certain viruses, whereas case 4 may be an instance of ocular as well as cranioneural pathoclasis, particularly if lewisite may be considered an agent capable of producing acute perivascular myelinoclasis of varying degrees, as shown by Putnam.[5] This speculation is further evidence of the possibilities and ramifications of the original problem.

4. Sagher, E.: Zentralbl. f. d. ges. Ophth. **34**:305, 1935.

5. Putnam, T. J.: J. Psychiat. & Neurol. **44**:460, 1932; Studies in Multiple Sclerosis: "Encephalitis" and Sclerotic Plaques Produced by Venular Obstruction, Arch. Neurol. & Psychiat. **33**:929 (May) 1935; Disseminated Encephalomyelitis, ibid. **41**:1087 (June) 1939; Bull. New York Acad. Med. **17**:337, 1941.

The case reported by Mogan and Baumgartner [3] as one of "Ménière's disease complicated by interstitial keratitis" is strikingly similar to the present case. The disease began as an iritis and interstitial keratitis in an apparently healthy man aged 26 whose past history and physical examination were without significance. There soon appeared periodic episodes of bilateral involvement, with recurrences every two weeks, each attack lasting three or four days. An explosive type of Ménière's disease occurred two months after the ocular onset. This was characterized by nausea, vomiting, vertigo, tinnitus and deafness. Both ocular and aural attacks were symmetric and regular in frequency. The prodromal symptom indicating an ocular attack was a peculiar conjunctival pallor, followed shortly by hyperemia, corneal cloudiness and pain. Visual acuity was reduced to 20/100 with each attack. The ocular and aural symptoms persisted for four days, with many recurrences during the year, at the end of which time ganglionectomy was performed. There was rapid improvement in and almost complete disappearance of ophthalmic and otologic symptoms.

The authors stated the belief that, because of the striking results obtained with ganglionectomy, a disease of the sympathetic nervous system should be strongly considered as an etiologic factor in Ménière's disease. Histopathologic studies of the resected ganglions revealed chromatolysis and crenulation of the ganglion cells. The significance of these changes was not determined. Foreign protein therapy was administered in this case notwithstanding the fact that a vasomotor storm was suspected, a procedure which apparently is contraindicated (Putnam [5]).

It has been assumed that in the case reported a response to a virus vaccine occurred with the help of foreign protein in the form of typhoid and paratyphoid vaccine, by producing a reaction in sensitized nerve tissue. The possibility that the brain had been sensitized can only be assumed, since the patient was undergoing revaccination. That such an allergic state may be produced in nerve tissue has been shown experimentally; that a very constant incubation period may be shortened, especially when there is no cutaneous "take," has been shown clinically.

The significance of the host in these infections can better be understood by studying a case described by Gentili.[6] This author reported on the occurrence of encephalitis in identical twins, the primary complication in each patient being involvement of the optic nerve. The initial case of encephalitis occurred in twin A at the age of 2 months. The chief complication, bilateral blindness, was the result of optic neuritis. Encephalitis occurred in the second twin at 16 months of age; again, the primary complication was bilateral optic neuritis. In each case there was return of vision to normal after several weeks; yet no clear concept was reached as to the type of encephalitis. The predisposition of these twins to ocular complications, particularly with involvement of the visual elements of the brain in a variegated type of

6. Gentili: Lattante **8**:286, 1937.

encephalitis, not only points toward specificity of neural tissue, but emphasizes the importance of host over virus in the pathogenic picture.

Finley [7] conclusively demonstrated that in acute postvaccinial encephalitis the most striking pathologic changes occurred in the perivenous areas. These changes were shown to be an extra-adventitial perivascular reaction with secondary progressive glial proliferation and demyelination along the veins for varying distances. Strikingly, the large, long-coursed vessels showed the most involved perivenous reaction, as reported by Davidoff, Seegal and Seegal.[8] It would seem, therefore, that the distribution of the perivascular lesions is determined in large part by the anatomic relations of the veins of the central nervous system. Finley,[7] in his series of 16 cases with autopsy, demonstrated in all sections of the pons that the large blood vessels were chiefly involved. In the pons the most numerous and the largest veins are branches of the paramedial vein, lying lateral to the median raphe and passing to the basilar vein. Studies of photomicrographs of the pons showed the perivenous glial lesions concentrated about the more medially situated venous channels. The lateral, smaller vessels were hardly involved. Such a distribution could in a measure explain the peculiar bilaterality and the equally peculiar cranial nerve dualism seen in our case. Lucksch [9] noted a perivascular infiltration in the pons in 2 cases with autopsy. Schindelha and Folger,[10] in reporting 4 additional cases of postvaccinial encephalitis (in 1 of which autopsy was performed) found a similar type of reaction in the pons. Greenfield,[11] too, noted the remarkable constancy in the distribution of the lesions in the brain stem and basal ganglions in these cases of encephalitis.

I have tried to show that in the rare syndrome of interstitial keratitis associated with vestibuloauditory symptoms described by Cogan one may be dealing with an atypical encephalitis in which the mode of extension is centrifugal. It is also known that in experimental dendritic keratitis there not infrequently occurs a herpetic encephalitis. It would seem, therefore, that there is some possibility of extension of virus along the fifth nerve in either direction. Such a possibility is not remote in the virus disease of measles, in which the conjunctival and corneal nerve endings are evidently in close relation to the offending virus.

7. Finley, K. H.: Perivenous Changes in Acute Encephalitis Associated with Vaccination, Variola and Measles, Arch. Neurol. & Psychiat. **37**:505 (March) 1937.

8. Davidoff, L. H.; Seegal, B. C., and Seegal, D.: J. Exper. Med. **55**:163, 1932.

9. Lucksch, F.: Med. Klinik **20**:1170, 1924.

10. Schindelha and Folger, cited by Glanzmann, E.: Schweiz. med. Wchnschr. **57**:145, 1927.

11. Greenfield, J. G.: Brain **52**:171, 1929; J. Path. & Bact. **33**:453, 1930.

SUMMARY AND CONCLUSIONS

A case of interstitial keratitis associated with vestibuloauditory symptoms is reported and a possible etiologic factor is suggested.

In a subsequent communication it is hoped to demonstrate the relation of this syndrome to postvaccinial encephalitis.

Stress should be placed on the important role the ophthalmologist should play in the early detection of postvaccinial encephalitis through observation of ocular complications.

692 High Street.

RETINOBLASTOMA (RETINAL GLIOMA) CURED BY RADON SEEDS

Report of a Case

JOSEPH WALDMAN, M.D.
AND
C. E. G. SHANNON, M.D.
PHILADELPHIA

SINCE the cure or arrest of retinoblastoma by any method of treatment is rare, we believe that any case in which either of these results has been obtained should be reported. It cannot be overemphasized, however, that the method of treatment applied in a single case should not necessarily be used as a rigid criterion for all cases.

Martin and Reese,[1] in an excellent study entitled "Treatment of Retinoblastoma Surgically by Irradiation," listed the cases of spontaneous cure, therapeutic cure and arrest. The same authors[2] have published additional information on their method of roentgenotherapy and the condition of their patients to date. Their results will stand as a monumental contribution to treatment of this malignant disease. Others[3] have reported cases in which treatment with roentgen radi-

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From the Department of Ophthalmology, Jefferson Medical College Hospital, Service 2.

Read at a meeting of the College of Physicians of Philadelphia, Section on Ophthalmology, Oct. 23, 1947.

1. Martin, H., and Reese, A. B.: Treatment of Retinoblastoma Surgically and by Irradiation, Arch. Ophth. **16**:733-761 (Nov.) 1936.

2. (*a*) Martin, H., and Reese, A. B.: The Treatment of Retinoblastoma (Retinal Glioma) by a Combination of Surgery and Radiation, Tr. Am. Acad. Ophth. **45**:70-91 (March-April) 1941; (*b*) Treatment of Retinoblastoma (Retinal Glioma) Surgically and by Irradiation, Arch. Ophth. **27**:40-72 (Jan.) 1942; (*c*) Treatment of Bilateral Retinoblastoma: Progress Report, ibid. **33**:429-439 (June) 1945. (*d*) Reese, A. B.: Effects of Radiation on the Eye, Am. J. Ophth. **29**:1160-1162 (Sept.) 1946.

3. Smaltino, M.: Glioma Cured by Roentgenotherapy: Report of Case, Boll. d'ocul. **15**:551-568 (May) 1936. (*b*) Ronstrom, H.: Glioma Treated with Roentgen Rays: Observation Through Period of Twelve Years, Acta ophth. **14**:361-379, 1936. (*c*) Bokerman, L.: Roentgenotherapy of Glioma: Report of Case, Ztschr. f. Augenh. **91**:348-352 (April) 1937. (*d*) Scheyhing, H.: Roentgenotherapy of Glioma, Klin. Monatsbl. f. Augenh. **98**:756-762 (June)

ation or with radium met with varying degrees of success. Excision of intracranial extensions of glioma has been combined with enucleation.[4] Retinoblastoma has also been treated by direct electrocoagulation, with inconstant results.[5]

One of us (J. W.) described a new method of applying radon seeds for ocular disorders.[6] This method was devised to overcome the difficulties that may occasionally be encountered in inserting radon seeds directly into the tumor [3] or in applying them, embedded in dental stent, to the overlying sclera of the posterior part of the globe in cases of retinoblastoma, as described by Stallard.[7] Briefly, the method consists in the application of a thin, semipliable chromium-plated or rhodium-plated silver band applicator containing depressions in the distal end into which the required number of radon seeds fit (fig. 1).

1937. (*e*) Knapp, P.: Permanent Cure of Glioma by Roentgen Irradiation, ibid. **99**:527 (Oct.) 1937; further report on Knapp, P., and Lüdin, M.: Cure of Retinal Glioma by Irradiation, ibid. **83**:279-284 (Aug.-Sept.) 1929. (*f*) Weiterschau, J.: Radiation Treatment of the Retinal Glioma, ibid. **102**:359-372 (March) 1939. (*g*) Bailliart, P.; Bellot, A., and Tilli, H.: Bilateral Glioma Treated by Radium: Report of Case, Bull. Soc. d'opht. de Paris **51**:364-369 (June) 1939. (*h*) Anderson, J. R.: Prognosis and Treatment of Retinoblastoma, Ophthalmologica **98**:193-200 (Dec.) 1939. (*i*) Jushaus, R.: Prognosis of Glioma, Klin. Monatsbl. f. Augenh. **105**:45-54 (July) 1940. (*j*) Schoenberg, M. J.: Case of Bilateral Glioma of Retina, Arch. Ophth. **48**:485, 1919; Case of Bilateral Glioma of Retina, Cured in Non-Enucleated Eye by Radium, ibid. **56**:221-228 (May) 1927. (*k*) Sorsby, A., cited by Traquair, H. M., in discussion on Hine,[3m] p. 105. (*l*) Moore, R. F.; Stallard, H. B., and Milner, J. G.: Retinal Gliomata Treated by Radon Seeds, Brit. J. Ophth. **15**:673-696 (Dec.) 1931. (*m*) Hine, M. L.: Diseases of the Retina, Tr. Ophth. Soc. U. Kingdom **64**:99-106, 1944; (*n*) ibid. **57**:173-186, 1937. (*o*) Philps, S.: Radon Seeds in the Treatment of Glioma Retinae, ibid. **64**:107-114, 1944. (*p*) Joyce, A.: Glioma of the Retina Cured by Radon Seed Implantation, Tr. Ophth. Soc. Australia **4**:98, 1944.

4. (*a*) Jean, G. W.: Discussion, Arch. Ophth. **51**:505, 1922; cited by Ray and McLean.[4b] (*b*) Ray, B. S., and McLean, J. M.: Combined Intracranial and Orbital Operation for Retinoblastoma, Arch. Ophth. **30**:437-445 (Oct.) 1943. (*c*) Dott, N. J., and Meighan, J.: Intracranial Resection of the Optic Nerve in Glioma Retinae, Am. J. Ophth. **16**:59, 1933. (*d*) Rand, C. W.: Glioma of the Retina: Report of a Case with Intracranial Extension, Arch. Ophth. **11**:982-994 (June) 1934. (*e*) Shannon, C. E. G.; Jaeger, R., and Forster, F. M.: The Combined Intracranial and Orbital Operation for Bilateral Retinoblastoma, Tr. Am. Ophth. Soc. **62**:326-333, 1944.

5. Weve, H. J. M.: Electrocoagulation and Use of Diathermy in Ophthalmology; abstracted, Am. J. Ophth. **18**:575 (June) 1935. deRoetth: Treatment of Bilateral Retinoblastoma, Northwest Med. **43**:364, 1944.

6. Waldman, J.: A New Method of Applying Radon Seeds for Ocular Disorders, Arch. Ophth. **23**:55-59 (Jan.) 1941.

7. Stallard, H. B.: A New Technique for the Application of Radon Seeds to the Sclera in the Treatment of Glioma Retinae, Brit. J. Ophth. **22**:604 (Oct.) 1938.

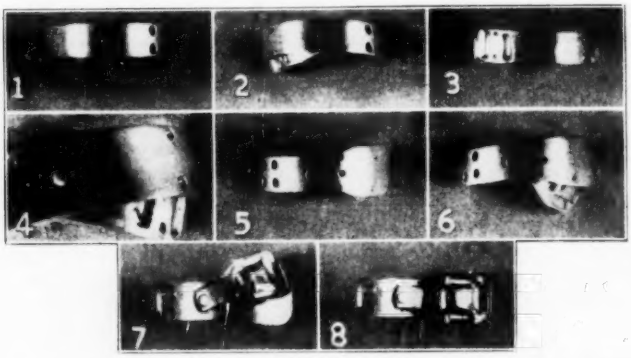

Fig. 1.—The applicator for two radon seeds is shown in *1* to *4*, inclusive, slightly enlarged, the applicator in *4* being enlarged approximately three times; and the applicator for four seeds is shown in *5* to *8*.

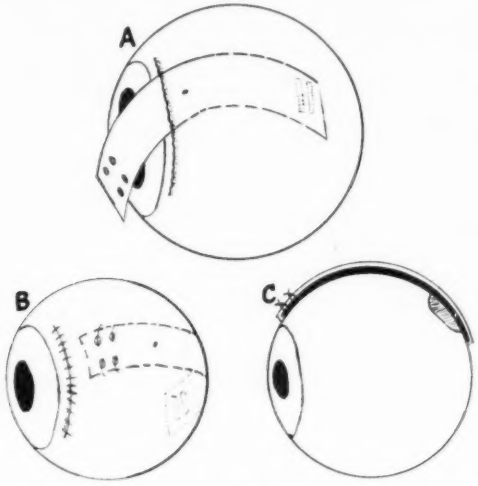

Fig. 2.—*A*, diagrammatic representation of the applicator with two radon seeds being inserted under the conjunctiva and Tenon's capsule. *B*, diagrammatic representation of the applicator with two radon seeds in place, "buried" under the conjunctiva and Tenon's capsule and sutured to the sclera. *C*, diagrammatic representation of the lateral view of the applicator in place, "buried" under the conjunctiva and Tenon's capsule overlying the retinoblastoma and sutured to the sclera.

The length of the band depends on the location of the tumor as measured from a fixed point on the eyeball (e. g., the limbus) in a particular meridian. This applicator follows the contour of the eyeball (fig. 2*A*) and is "buried" (fig. 2*B* and *C*) under Tenon's capsule and the conjunctiva. Precautions are taken to avoid injury to muscles, vortex veins and other anatomic structures. The proximal

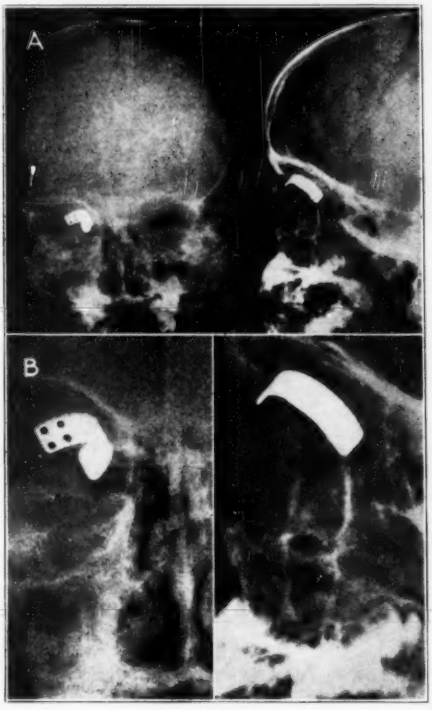

Fig. 3.—Anteroposterior and lateral roentgenograms (*A*, reduced, and *B*, slightly enlarged), showing the applicator in place.

end is sutured to the sclera from the fixed point of reference. The applicator (fig. 3*A* and *B*) with the radon seeds is left in situ for the desired length of time. Then the appliance is removed with the seeds in place by opening the conjunctiva at the proximal end and reclosing it. Thus, the possible difficulties encountered in suturing at the posterior parts of the eyeball are eliminated. The reaction caused by the applicator itself is negligible. The application of radon

seeds may thus be repeated at such intervals, and in such doses, as are deemed necessary for the proper treatment of the tumor.

We are in accord with the conclusions of Martin and Reese that the method of treatment for bilateral retinoblastoma should be enucleation of the more involved eye and fractionated radiation therapy of the other, if there is a chance to control the disease and conserve vision and if the technical facilities are available.

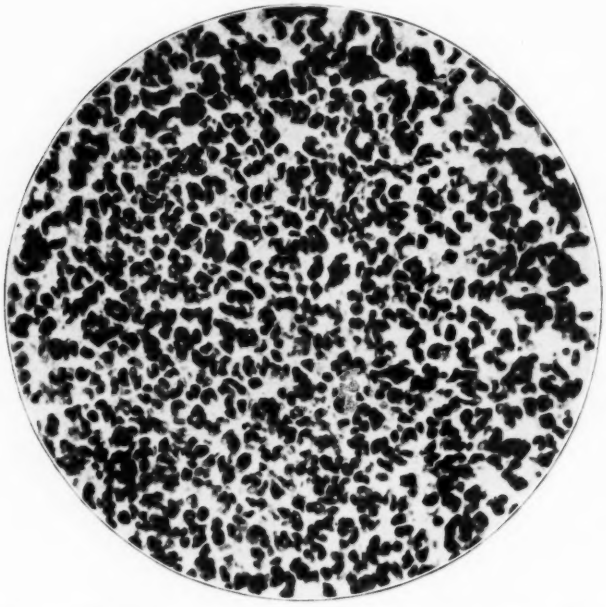

Fig. 4.—Retinoblastoma from the enucleated left eye; × 400; hematoxylin and eosin stain.

REPORT OF CASE

E. C., a white boy aged 13½ years, was first seen in the children's clinic, Jefferson Medical College Hospital, on March 20, 1934, at the age of 1 month. The diagnosis was hypospadias. The child had had a normal birth. Three other children were living and well; there was no familial ocular disease. The patient was brought to the eye dispensary on Jan. 22, 1935, at the age of 10 months, because his mother noticed a grayish reflex from the left eye ("cat's eye reflex"). She stated that at the age of 2 months she noticed an occasional "turning in" of the left eye, which was not present at the time of admission. This grayish spot had increased in size in the last two months. There was no history of injury or of

acute infection. The eyes had never been red. Examination revealed that the eyelids, rotation, tension (right eye, 18 mm.; left eye, 18 mm. [Schiøtz]), conjunctiva and pupillary reactions to light and in convergence were normal. With oblique illumination, a grayish white reflex was obtained in the left pupil. Ophthalmoscopic examination was done with the patient under a general anesthesia. The media and the fundus of the right eye were normal. Almost the entire posterior segment of the left eye seemed to be filled with a grayish white growth, somewhat irregular in contour and studded here and there with tiny blood vessels, which showed up easily by contrast with the white background. No other details were seen. The diagnosis of retinoblastoma was made. The patient was seen by several members of the staff.

Enucleation of the left eye was performed on January 29. No implant was used. Roentgenograms of the skull and chest and all the long bones revealed no evidence of any metastatic change. The blood count, serologic tests and urinalysis gave normal results. The pathologic report was retinoblastoma (fig. 4).

On March 27, 1935, 50 mg. of radium in a small pack was applied for thirty minutes to the region of the left temple.

Subsequent Course.—Dec. 12, 1935: Right eye: The media and fundus were normal. Left eye: The socket was clean.

May 13, 1938: Right eye: The external appearance was normal; the pupil reacted normally to light and in convergence. Ophthalmoscopic examination with the pupil dilated revealed that the media were clear, the disk oval, the color good, the cup slightly full and the margins somewhat blurred; no lamina cribrosa was seen; the vessels were generally normal. About 4.5 to 5 disk diameters from the nasal margin of the nerve, in the 1:30 o'clock meridian, was a silver gray mass, elevated 1.25 D., which was 2 disk diameters long and 0.5 disk diameter wide and lay in a fork of the superior nasal vein. The mass was roughly triangular, with the apex at the vessel. Smaller vessels were seen to cross over and lie directly on the growth. There was no evidence of pigmentary disturbance or hemorrhage in the involved area (fig. 5). The macular area and the rest of the fundus appeared normal.

Left eye: The socket was clean.

A course of roentgenotherapy for the retinoblastoma of the right eye was decided on.

Oct. 26, 1938: The size and height of the tumor were slightly increased. Below it were two small, dark red areas of retinal hemorrhage, each about 0.25 disk diameter in width.

Nov. 15, 1938: Vision was 6/9; 1 radon seed (2.5 millicuries), embedded in dental stent, was sutured in place on the sclera overlying the growth for 113.75 millicurie hours. Then one application of 1 radon seed and three applications of 2 radon seeds (2.5 millicuries each) were made during the period up to November 1939. The retinoblastoma gradually disappeared. Pigmentary and retinochoroidal changes with beginning irradiation cataract (the latter appearing eighteen months after the first treatment) developed during this period.

April 1942: It was thought that three tiny silvery areas with punctate retinal hemorrhages in the 11:30 meridian, 2 disk diameters above the nerve, were evidences of new growth.

May 1, 1942: Three 2.5 millicurie radon seeds were applied in this area.

May 10, 1943: Vision was 20/70 in the right eye with correction; the fundus was free of growths.

Jan. 29, 1944: Vision was 20/100 in the right eye with correction.

March 15, 1946: Vision was 5/60 in the right eye with correction. A detailed study of the fundus was difficult because of the extensive changes in the lens (irradiation cataract). The macular area was now extensively spotted with small retinal hemorrhages and bright, sharply defined, yellowish white areas with delicately pigmented borders, which resembled somewhat part of a macular "star." Extensive changes were noted in the retina and choroid in the upper central and temporal areas. Here the choroidal circulation was clearly visible, and brown, dustlike pigmentary changes were observed over an extensive mottled area. The original area of choroidal atrophy in the upper nasal quadrant remained unchanged.

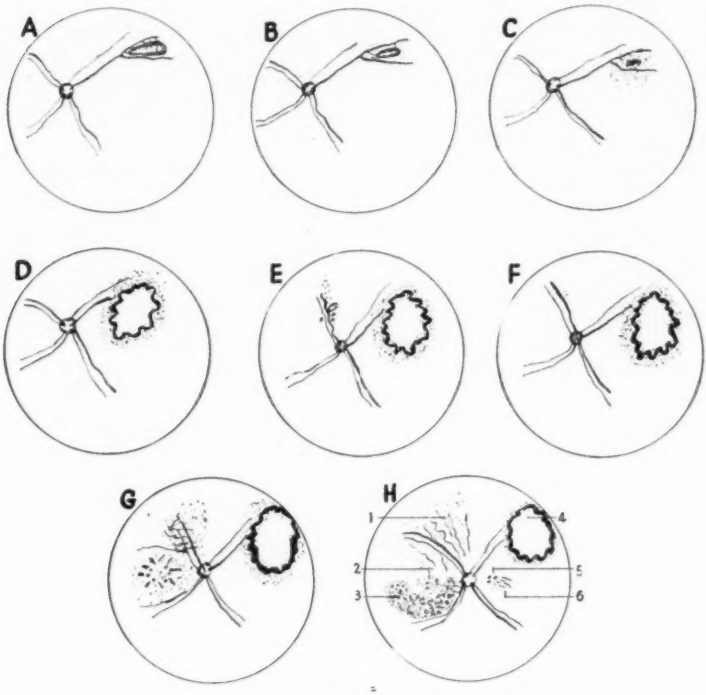

Fig. 5.—Diagrammatic representations of the retinoblastoma in the right eye, as seen chronologically.

A (May 13, 1938), original appearance of the retinoblastoma; *B* (Sept. 28, 1939), after two applications of radon seeds; *C* (Nov. 27, 1939), after five applications of radon seeds; *D* (November 1940), after five applications of radon seeds; *E* (April 21, 1942), just before the sixth application of radon seeds; *F* (December 1942), approximately seven months after the sixth application of radon seeds; *G* (March 15, 1946); *H* (1947), showing (*1*) choroidal vessels and dustlike brown pigment, (*2*) miliary aneurysms, (*3*) area resembling circinate retinitis, (*4*) area of choroidal atrophy, (*5*) silvery bodies and (*6*) punctate and fine linear hemorrhages.

There was a partial symblepharon in the upper nasal fornix at the site of the previous operations. The bulbar conjunctiva in this area was pigmented, with increase in vascularization and a tiny telangiectatic spot, about 1 mm. in diameter, in the extreme upper temporal fornix. Examination with the slit lamp revealed a few punctate, brown endothelial dots and a small, tonguelike projection of vascularized conjunctiva 1 mm. to the side of the cornea, at 1 o'clock, with slight increased capillarity at the upper limbus. The aqueous and iris were normal. Changes in the lens due to irradiation were more advanced than on previous examination. There had been no pain or discomfort in the eye since the last application of radon, in May 1942. No rise of intraocular tension was noted throughout the course of treatment.

Nov. 4, 1946: The patient went to the Overbrook School for the Blind and was learning Braille. Vision was 6/60 in the right eye without correction and was not changed with correction; the media and fundus were unchanged; biomicroscopic examination revealed no change since the previous examinations.

March 10, 1947: External examination revealed essentially the same condition as before. Beginning at the temporal border of the nerve, and extending in a comet-shaped area, was a golden yellow area, resembling the lacelike pattern of circinate retinitis. It stood out in sharp contrast to the darker macular area and the rest of the fundus. In the macular area itself were numerous tiny aneurysms and capillary dilatations, involving primarily the venous branches. Above the macular area, the fundus was somewhat mottled and faded, with some absorption of pigment and seemingly covered with brown, powdery pigmentation. The old atrophic area in the upper nasal quadrant noted previously was slightly elevated (?) because of proliferation of fibrous tissue. About 1.5 disk diameters from the nasal border of the nerve were a series of minute capillary dilatations, resembling punctate hemorrhages. In this cluster were a few faint, woolly, silvery, dark areas. Here and there throughout the fundus some of the veins showed sausage-like constrictions. Vision was 6/60 without glasses with undilated pupil, as tested on three different charts.

Oct. 15, 1947: Right eye: Under cycloplegia with 1 per cent atropine sulfate, a correction of $+1.25$ D. $\bigcirc$ $+2.00$ cyl., axis 90 gave vision of 6/60. Tension (Schiøtz) was 19 mm. (seen by Dr. William Zentmayer). The changes in the lens and the condition of the fundus were essentially as noted on previous examination. Biomicroscopic examination revealed slightly increased vascularity in the upper nasal limbus; the cornea was otherwise normal; the aqueous was normal, and the iris appeared as before; irradiation cataract persisted.

Résumé of Operations on the Left Eye.—1. Enucleation, on Jan. 29, 1935, was followed by radium therapy on March 27, 1935; 15 mg. in a small pack was applied to the left temple for thirty minutes. The pack consisted of 10 needles in a monel® metal covering 0.3 mm. thick, each needle containing 5 mg. of radium. These were placed in a lead box (dimensions not available) with an ordinary blotter and a layer of ordinary adhesive tape for filter on the surface next the skin.

2. Five applications of radon seeds in a special holder and 1 radon seed embedded in dental stent, for a total of 3,760 millicurie hours, were given between November 1938 and May 1942.

Roentgen Treatment of the Right Eye.—First Series (May 18, 1938 to June 10, 1938): The factors were as follows: dose, 200 kilovolts; distance, 50 cm. (laterally) to the temporal side; filter, 0.5 mm. of copper and 1 mm. of aluminum. The first treatment was 64 r, and each treatment thereafter, 160 r, for a total of 1,504 r.

Second Series (July 28, 1939 to August 24, 1938): A total of 1,600 r was given, making a grand total of 3,104 r.

SUMMARY

A patient with retinoblastoma (verified by microscopic and gross study of the enucleated eye) has been treated and observed for twelve years. Retinoblastoma in the remaining eye has been treated, with cure for a period of nine years (1938).

Enucleation of one eye was performed in 1935, when the patient was 18 months of age. The optic nerve was microscopically free of tumor cells.

Roentgenotherapy to the right eye was given as outlined here. It will be noted that the total of 3,104 r given was far below the dose advised by the fractionated method of Martin and Reese.[3a] In November 1938, 2.5 millicuries of radon was applied in dental compound and sewed to the overlying sclera. Five applications of radon seeds were used in the holder previously described[6] from March 1939 to May 1942.

The patient was 10 months old when treatment was instituted and is 13½ years old at the time of this report. Typical irradiation cataract and changes in the fundus, probably incidental to radon therapy, are described. Visual acuity is 6/60. The patient attends a sight-saving school. The changes in the lens, and perhaps the macular changes as well, may become more pronounced.

In retrospect, the areas thought to be new growths in April 1942 may quite possibly have been a late reaction to the radon applied previously. This condition has been noted and described by Martin and Reese[2d] in their large series treated by fractionated roentgen irradiation.

CONCLUSIONS

We can do no better than endorse the procedure of Martin and Reese in the treatment of retinoblastoma: (1) for unilateral ocular involvement, prompt enucleation with as long a section of the optic nerve as possible, and frequent ophthalmoscopic examinations for five years; (2) for bilateral involvement, prompt enucleation of the more diseased eye and radiation therapy, with the idea of saving life and

conserving vision in the remaining eye if the growth is not too far advanced and the specialized technic of fractionated roentgentherapy is available.

For ocular and intracranial involvement of relatively easily accessible areas, intracranial approach and excision of growths with enucleation are recommended.

The local use of radon by the method described [6] is recommended as another form of treatment of this malignant disease, particularly when the exact and careful technic of fractionated roentgenotherapy described by Martin and Reese is not available.

MYDRIATICS

A Clinical Observation

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THE PURPOSE of this paper is to evaluate the clinical merit of the commonly available mydriatics as to such factors as safety, speed of action and return to normal pupillary size.

All drugs used in medicine have a range of dosage depending in part on the age of the patient and on whether the clinician desires the minimal or maximal effective dose for the patient in question. The same is true of drugs used in ocular diseases except that in ophthalmology particular care should be exercised when mydriatics are used. The initial evidences of overdosage of any drug are not usually disastrous, and the discontinuation of the drug ordinarily leads to complete return to normal in a short time. This tendency does not prevail with mydriatics. The use of a mydriatic in a patient with "potential glaucoma" may terminate in a serious complication, with a blind eye as a result.

GLAUCOMA COMPLICATING THE USE OF MYDRIATICS

Occasionally there appears in the ophthalmologic literature the report of a case of glaucoma following the use of a mydriatic. H. Gifford [1] reported 11 cases of glaucoma which developed after use of a mydriatic, including that of a woman aged 21. Several of the audience present at the reading of his paper reported similar experiences with mydriatics. Gifford also reviewed the literature up to the time of the writing of his paper and mentioned accidental development of glaucoma following the use of cycloplegias, mydriatics and local anesthetics, such as duboisine, scopolamine, eucatropine, epinephrine and phenacaine. Horner and Bettman [2] reported a case of glaucoma following the administration of 1 drop of epinephrine bitartrate in a patient who had never had symptoms of glaucoma. Beach and Holt [3] reported 9 cases, with a range in ages of 19 to 70 years, which came under their observation. Their conclusion

From the Eye Clinics of the Hospital of the Protestant Episcopal Church and St. Christopher's Hospital for Children.

1. Gifford, H.: The Desirability of Using Miotics as Adjuvants to Mydriatics, J. A. M. A. **67**:112 (July 8) 1916.

2. Horner, W. D., and Bettman, J.: Am. J. Ophth. **19**:311, 1936.

3. Beach, S. J., and Holt, E. E.: Am. J. Ophth. **24**:668, 1945.

was that glaucoma is a rare condition, chiefly affecting women, that youth or the previous use of mydriatics is no bar to its development and that the attack is remedied quickly by strong miotics. They suggested a careful examination of the pupil and anterior chamber before a mydriatic is used. Goar [4] "spent an anxious half-day trying to contract a pupil in a patient with paredrine." He also operated on several patients in whom acute glaucoma developed after the instillation of epinephrine.

An unfortunate experience occurred in my practice.

Mrs D. M., aged 32, came for an examination of the eyes on Feb. 16, 1931, at 5 p. m. (the conclusion of office hours). She was told that there was no time then for a complete examination, but that a drop of medicine (1 per cent homatropine hydrobromide U. S. P.) would be instilled for examination of the fundus. She was to return the next day to complete the refraction. Her irises were brown and the anterior chambers normal, and the pupils reacted to light. The fundi were normal. She was not asked whether she saw halos. The procedure to be followed the next day would have been that observed in other cases, namely, instillation in each eye of 1 drop of homatropine hydrobromide, 1 per cent, at ten minute intervals for six doses. She did not report for examination the next morning, but on the evening of February 17 she called to say that she had had a gastric upset and a headache all day, which localized itself in a severe pain over the eye, and that her vision was dim. She was advised to go to the hospital immediately, where it was found that she had tension of 40 mm. in the right eye and of 50 mm. in the left eye. The blood and basal metabolic rate were normal; transillumination showed normal fundi, and a roentgenogram of the orbits revealed nothing remarkable. Physostigmine sulfate was used immediately, without effect. On the afternoon of February 19, an iridectomy was performed on both eyes, with resultant vision of 20/100 and 20/50. She was under continuous care for several months after this. Up to the present time she has never had a recurrence of the condition, and her vision is unchanged.

Aside from the rarity with which glaucoma follows the use of mydriatics, the ophthalmologist is thrown off his guard by the frequency of administration of strong mydriatics, such as the employment of atropine in maximum and frequent doses, regardless of the age of the patient, for the cure of corneal ulcer. If any complication takes place, it is oftener dermatitis rather than glaucoma.

In a desire to shorten the period of inconvenience of mydriasis, ophthalmologists have used powerful mydriatics with cycloplegic quality often; yet glaucoma has not been reported. Some investigators have used 1 or several drops of the mydriatic itself, and some have added a synergist.[5] Vandiver [6] dusted a small quantity of homatropine

4. Goar, F. L.: Tr. Am. Acad. Ophth. **46**:19, 1941.

5. Beach, S. J.: Connecticut M. J. **4**:140, 1940; Tr. Am. Acad. Ophth. **42**: 179, 1937. Beach, S. J., and McAdams, W. R.: Am. J. Ophth. **21**:121, 1938. Marron, J. J.: Cycloplegia, Arch. Ophth. **23**:340 (Feb.) 1940. Moncrieff, A., and Schriebel, R. J.: Am. J. Ophth. **24**:282, 1941. Sudranski, H. F.: Evaluation of Homatropine-Benzedrine Cycloplegia, Arch. Ophth. **20**:585 (Oct.) 1938. Tait,

(Footnote continued on next page)

powder into the eye and repeated the procedure if necessary. Hartshorne [7] used a cycloplegic with patients of 45 or 50 and cited Wiggers as never doing a refraction on a patient up to, or even over, 60 years of age without a mydriatic. The author specifically stated that in his cases he used a miotic to follow up the mydriatic.

A discussion as to whether absolute cycloplegia is essential to good refraction, as cited by Friedman,[8] is not within the scope of this paper except to state that the cycloplegic property in a mydriatic possibly prolongs the time within which the mydriatic is eliminated. Therefore, in a selection of mydriatics the one with the least cycloplegic effect is most desirable.

It is generally conceded that a mydriatic will not cause glaucoma in an eye not affected by this disease. Some ophthalmologists even go so far as to state that the giving of a mild mydriatic in the case of a questionable "preglaucomatous state" is indicated as a diagnostic measure in definitely determining the condition. The rationale of such a procedure is questionable and has been discussed by such an authority as Gradle.[9]

PRELIMINARY STUDY OF MYDRIATICS

To begin this study, it was necessary to establish an arbitrary minimal size to which all pupils must be dilated. Ordinarily, some eyes may be examined without any mydriatic; but it was felt, after questioning many ophthalmologists, that a pupil of 7 mm. would permit a thorough examination of the fundus, as well as make it possible to use the slit lamp effectively. With such dilations, one may avoid any errors of omission, such as may occur in the examination with an undilated pupil.

For the study of the relative efficiency of mydriatics, a group of drugs had been selected. The most suitable drug would be one which opened the pupil fastest and painlessly, with no untoward symptoms, and which could most easily be counteracted by the use of a mild miotic. In a previous, unreported, series of several thousand patients who had 1 to 3 drops of 1 per cent physostigmine salicylate instilled in the eyes every fifteen minutes until miosis was fully established, 2 patients became very faint, so that they had to lie down and stimulants had to be administered. One of these patients was almost pulseless. This condition was possibly brought on by the intense spasm of ciliary muscles and the violent pulling sensation which the patient experienced.

J. H.: J. Iowa M. Soc. **32**:162, 1942. Thorne, F. H., and Murphy, H. S.: Cycloplegics, Arch. Ophth. **22**:274 (Aug.) 1939. Weinman, F. B., and Fralick, F. B.: Am. J. Ophth. **23**:172, 1940.

6. Vandiver, H. F.: J. Oklahoma M. Soc. **33**:15, 1940.

7. Hartshorne, I.: Eye, Ear, Nose & Throat Monthly **19**:201, 1940.

8. Friedman, B.: Comments on Teaching of Refraction, Arch. Ophth. **23**: 1175 (June) 1940.

9. Gradle, H. S.: Am. J. Ophth. **30**:7, 1946.

To avoid such a reaction, the miotic chosen for this study was pilocarpine hydrochloride in 1 per cent solution. Five drops was used at each instillation every few minutes until the pupils closed down to 2 mm. or less. The mydriatic was permitted to expend itself without the assistance of a miotic in some cases (table).

In some cases the miotic had a meager, or no, observable effect, as in the case of homatropine and "eumydrin" (atropine methylnitrate). Patients were examined for mydriasis at various times of the day to see whether at certain periods better results were obtained in the dilation of the pupil.

Middleton and Chen [10] showed that in the study of cocaine, eucatropine and ephedrine the best mydriatic reaction was obtained with Caucasians, the next with Chinese and the poorest with Negroes. There is even an individual variation when a mydriatic is used on irises of the same color of different patients of the same age. It was unfortunate that of the patients studied, all were of the white race, with the exception of 1 Japanese and 2 Negroes; but the relative intractability of the heavily colored iris in white persons was often observed.

The studies began in the latter part of November 1946 and continued for about ten months. Of the drugs considered for this type of study, three were unobtainable, viz., benzilyloxyethyl-di-methylethylammonium chloride, known commonly as E 3, the clinical use of which was described by Riddell [11] and Mann [12]; the Russian mydriatic platyphylline, and "veritol" (para-hydroxyphenyl-isopropylmethyl amine) formate, described in the German literature. The last two are mentioned in the United States Dispensary, twenty-third edition.

Avoided in these studies was "mydricaine," [13] a preparation of atropine, cocaine and epinephrine, given subconjunctivally, and much too powerful for ordinary needs in ophthalmic practice.

Several drugs were not used in this study, for reasons to be stated. Synthetic epinephrine bitartrate [14] was discarded early because of its undesirable reaction. This white powder dissolves easily in buffer solution and makes a crystal clear 2 per cent solution, which after several weeks becomes dark brown, when it is considered useless. My experience with this drug was unpleasant in several cases. In these instances, a few minutes after its use, the sclera became blanched, the hands began to tremble, a cold sweat covered the face and the patient

10. Middleton, S. S., and Chen, K. K.: J. Pharmacol. & Exper. Therap. **36**: 429, 1929.

11. Riddell, W. J. B.: Brit. J. Ophth. **30**:7, 1946.

12. Mann, I.: Brit. J. Ophth. **30**:8, 1946.

13. Flynn, F.: Brit. J. Ophth. **17**:298, 1933.

14. The drug used was "suprarenin," a brand of epinephrine (synthetic) bitartrate powder.

Synthetic substances allied to the alkaloids of the belladonna group	Number of Patients	Number of Female Patients	Age Range, Yr.	Number of Drops Required						Size of Pupil, Mm.				Color of Iris			Time to Reach Maximum Mydriasis, Min.	Tension	Light Reflex Absent, %	Read 37 M. Type in Full Mydriasis, %	Time Taken to Contract Pupil		Eye Cleared
				1	2	3	4	5	6+	4	5	6	7 to Full D.*	Blue	Brown	Hazel					Spontaneous	With 1% Pilocarpine	
Homatropine hydrobromine, 1%	48	28	7-75	38	8	2	..	..	..	2	..	2	92	4	28	16	15 to 105	Some high normal	38	46	11 to 48 hr.	No effect	.....
"Syntropan," 6%.....	56	33	4-79	36	15	2	..	1	2	1	1	9	80	12	29	15	20 to 180	High normal	29	89	5 to 9 hr.	30 to 127 min.	60 to 180 min.
Atropine methylnitrate...	48	23	3-32	17	24	7	..	..	..	..	..	2	96	9	28	11	25 to 165	Some high normal	25	25	1 to 5 days	No effect	.....
Eucatropine hydrochloride, 1%	12	8	20-71	3	3	4	1	..	..	2	7	..	25	4	5	3	20 to 60	Normal	None	100	None tried	10 to 60 min.	At once
Eucatropine hydrochloride, 2%	61	44	13-80	11	23	19	5	2	1	1	3	13	72	11	32	18	40 to 105	Normal	7	100	2 to 8 hr.	30 to 80 min.	25 to 60 min.
Parasympatholytic Drugs: Choline esters																							
Dibutoline sulfate, 5%....	104	57	3-77	56	34	13	1	..	..	1	..	4	95	24	53	27	20 to 180	Normal	94	7	16 to 48 hr.	90 to 390 min.	No clearing period
Sympathomimetic drugs																							
Paredrine, 1%.....	78	47	9-74	35	27	9	6	1	..	6	..	9	81	25	35	18	20 to 115	Normal	6	100	Clear next a. m.	8 to 70 min.	½ to 5 hr.
Paredrine, 3%.....	108	72	8-80	74	12	13	3	3	3	13	5	21	64	21	62	25	20 to 128	Normal	24	17	Clear next a. m.	20 to 80 min.	1 to 5 hr.
Phenylephrine hydrochloride, 2.5%	44	31	8-80	21	12	8	2	1	..	3	..	6	80	11	14	19	20 to 180	High normal	91	86	70 to 120 min.	10 to 100 min.	No clearing period
Synergistic drugs																							
Racéphedrine and homatropine	10	5	7-65	2	4	3	1	..	..	5	1	4	0	1	..	9	None reached; full mydriasis	Normal	20	30	6 hr.	None used	.....
Ephedrine and homatropine	41	25	7-71	16	17	7	1	..	..	2	3	2	83	19	20	2	20 to 130	Normal	44	39	2½ to 19 hr.	15 to 120 min.	1½ to 10 hr.
Racéphedrine and eucatropine	58	37	13-77	10	20	17	7	3	1	7	2	9	69	16	27	15	25 to 170	Normal	85	81	2 to 9 hr.	15 to 180 min.	1 to 5 hr.

* Dilatation, expressed as a per cent.

became nauseated. In 2 of the cases several hours elapsed before a return to normal. After the use of this drug was repeated, these untoward symptoms lessened somewhat. The manufacturers are aware of these shortcomings and suggest that the patient be forewarned. The advisability of using this preparation in the face of such secondary effects is questionable.

Horner and Bettman [2] and Post [15] stated that 1 per cent cocaine with 1 per cent eucatropine hydrochloride U. S. P. is desirable as a mydriatic because this combination can be counteracted more easily and less painfully; but the combination has a tendency to increase intraocular tension in the normal eye of elderly persons, and the pupil hardly approached the diameter of 7 mm. which was arbitrarily established.

Howard and Lee [16] used epinephrine hydrochloride. They claimed, however, that a stinging sensation, headache and nausea were associated with its use. In this study ephedrine was used only with homatropine hydrobromide (table), for reasons to be explained later.

Cocaine was not used on account of the occasional corneal softening and the frequent corneal edema, which makes ophthalmoscopic and biomicroscopic examinations difficult.

TYPES OF DRUGS STUDIED

The mydriatics studied may be arbitrarily divided into four groups.

1. Synthetic substances allied to the alkaloids of the belladonna group.[17]

Homatropine hydrobromide, 1 per cent
Atropine methylnitrate ("eumydrin"), 1 per cent
Eucatropine hydrochloride, 1 per cent
Eucatropine hydrochloride, 2 per cent
"Syntropan," (the phosphate of 3-diethylamino-2,1-dimethylpropyl esters of tropic acid), 6 per cent

These drugs, like atropine, are all optically racemic. Unlike atropine, however, which occurs in nature, the drugs studied are all synthetic preparations. The more powerful mydriatics with definite cycloplegic properties, such as atropine, scopolamine and duboisine, were not used in this study, for obvious reasons.

2. Choline esters

Dibutoline sulfate, 5 per cent (dibutylcarbamate of dimethylethyl-β-hydroxyethyl-ammonium sulfate)

15. Post, L. T.: Am. J. Ophth. **20**:33, 1937.

16. Howard, H. J., and Lee, T. P.: Proc. Soc. Exper. Biol. & Med. **24**:700, 1926.

17. Goodman, L., and Gilman, A.: The Pharmacological Basis of Therapeutics. New York, The Macmillan Company, 1941, p. 462.

3. Cholinergic drugs

"Paredrine hydrobromide ophthalmic" (1 per cent solution of *p*-hydroxy-α-methylphenylethylamine hydrobromide in distilled water, made tear isotonic with 2 per cent boric acid and preserved with merthiolate, 1:50,000)

"Paredrine hydrobromide" (*p*-hydroxy-α-methylphenylethylamine hydrobromide), 3 per cent

Phenylephrine ("neo-synephrine") hydrochloride, 2.5 per cent

4. Drugs of group 1 augmented by the synergistic action of either ephedrine or racéphedrine (*racemic*-1-phenyl-2-methylaminopropanol-1)

Ephedrine hydrochloride, 1 per cent, and homatropine hydrobromide, 1 per cent
Racéphedrine hydrochloride, 1 per cent, and homatropine hydrobromide, 1 per cent
Racéphedrine hydrochloride, 1 per cent, and eucatropine hydrochloride, 1 per cent

Although it is felt by some investigators that a low p_H tends to better results in the use of mydriatics, de Cori and Wiechmann [18] reported that a shift in the p_H to the alkaline side increases the speed and efficiency of both mydriatics and miotics. Thus, with the exception of preparations coming already prepared, such as dibutoline sulfate and phenylephrine hydrochloride, all the solutions used in the series were prepared in a boric acid-sodium borate ("borax") buffer with a p_H of 7.0 to 7.3.[19]

TECHNIC

All mydriatics were instilled at 12 o'clock at the limbus with the head of the patient tilted backward or with the patient lying down. The mydriatic was allowed to flow slowly over the suface of the cornea, and the eyelids were kept open for about one-half minute. In the case of a young patient it was impractical to have him lie down while the drops were inserted, since the child became apprehensive and did not cooperate well. For a similar reason, it was not possible to obtain the intraocular pressure in patients of the younger group. In much the same way, some of the older patients were not very cooperative in tests for cycloplegia. The eyes of the patient were observed every ten to fifteen minutes; additional drops of the mydriatic were instilled only when the pupils during these intermittent examinations showed no tendency to further dilation. The droppers [20] used in this study were of the "clinical type," with which each drop weighed the same. The same mydriatic was used in the two eyes except when otherwise stated.

Bothman [21] showed that many of the ill effects of strong cycloplegics were obtained by absorption of the drug through the tear duct, and it is now generally recognized that there is less absorption of the mydriatic when the lacrinal puncta

18. de Cori, R., and Wiechmann, R.: Read at the Fifteenth Meeting of the International Congress of Ophthalmology, Dec. 8, 1937; abstracted, Arch. Ophth. **20**:145 (July) 1938.

19. Feldman, J. B.: p_H and Buffers in Relation to Ophthalmology, Arch. Ophth. **17**:797 (May) 1937.

20. Phenylephrine and dibutoline are dispensed with their own droppers. In the case of dibutoline solution, the drops are smaller than the others used in this study; 21½ drops from the dibutoline bottle equals 0.5 cc. This is equivalent to 15 drops from the "clinical dropper."

21. Bothman, L.: Tr. Am. Acad. Ophth. **42**:164, 1937.

are compressed. However, in this group, no attempt was made to compress the tear duct. It was felt desirable to see what untoward symptoms would arise by nasal absorption of the drugs used.

The mydriatics were used at room temperature. The instillation of the mydriatics and miotics, as well as the observations, were made by myself.

For each patient were recorded the name, age, sex, time of day at which the drop was inserted, time when successive drops were used, progress of mydriasis and resultant dilatation of from 7 mm. to maximum diameter. Also noted were the approximate size of the anterior chamber, the color of the iris and the diameter of the pupil when the instillations were begun. When obtainable, the ocular pressure was procured before the mydriatic was instilled and again at the maximum dilatation. The progress of the miosis with pilocarpine hydrochloride was noted, and such other comments as were deemed essential in the analysis of the cases were made. The intraocular pressure was taken with the use of 1 per cent butacaine sulfate U. S. P. ("butyn sulfate"). A Schiøtz tonometer was used.

None of the patients had synechias. In each patient, the pupils reacted to light and in accommodation. All measurements of pupillary diameter were made in the same room with equally diffused light. A pupillometer with a Venier device for accuracy was used. When the drops were flicked out, the case was discarded.

Since it is desirable that at least in such a subjective test as that for cycloplegia in which the Prince rule is used the refraction be as nearly correct as possible, each patient came for several visits for perfection of his refraction prior to the mydriatic study. Some of the adults were illiterate or irresponsible or had cataracts, and were therefore unsuitable for this test.

When the pupil was maximally dilated for the individual subject, an effort was made to see whether there was a pupillary reflex and whether the patient could read 37 M. type. Glasses were used here if there was a refractive error.

It was frequently found that the time consumed in contracting the pupil with pilocarpine after full mydriasis was seldom as long as the time necessary for maximum dilatation. This may have been due to the fact that more drops of 1 per cent pilocarpine nitrate were used at each instillation (5 drops of miotic against 1 drop of mydriatic) and that the miotic was more frequently instilled than the mydriatic (about every five minutes, regardless of the degree of pupillary contraction).

Except for severe burning after the instillation of a few mydriatics, some subconjunctival injection following the instillations of pilocarpine and the experience with epinephrine bitartrate, no complications were observed, and the corneas were all clear.

Cycloplegia was checked with the correct refraction worn. In addition, a + 3 D. lens was placed before each eye, together with a 3 mm. disk opening to compensate for the fully dilated pupil. The patient was required to read the 37 M. type. There were several shortcomings in this test with respect to the present study: (1) The test was subjective, so that the validity of the patient's answer was questionable, and (2) the test for cycloplegia was made at the height of mydriasis, which may have been obtained before cycloplegia set in.

MYDRIATICS

Homatropine Hydrobromide, 1 Per Cent.—Homatropine hydrobromide was the first mydriatic studied in this series. Only 1 per cent of the drug, dissolved in buffer solution,[19] was used. It was deemed desirable to use the weakest dilution of the mydriatic selected which would prove effective in dilating the pupil maximally.

This drug comes prepared in powder form or in soluble ½ grain (0.032 Gm.) tablets. It is a synthetic preparation allied to the belladonna alkaloids. This mydriatic differs from atropine in that it is derived from a tropine base and mandelic acid, while atropine is derived from tropic acid.[17]

Forty-eight patients were examined, the ages ranging from 7 to 75 years; the majority of the patients were under 35 years of age (table). Forty-four patients obtained maximum dilatation of the pupil. One exceptional patient obtained maximum dilatation in fifteen minutes. Wolf and Hodge [22] gave the time for maximum cycloplegia with homatropine at between thirty and ninety minutes. With a patient obtaining full dilatation in fifteen minutes, one can understand how a test for cycloplegia would not be valid.

Only in 2 cases would a determination of the intraocular pressure be permitted by the patient. Both had normal tensions. With the pupil fully dilated, about one third of the patients did not have a light reflex, and about one-half could not read 37 M. type with their corrections. Seven to 11 drops of pilocarpine hydrochloride, 1 per cent, had no immediate pronounced effect on the pupils, but shortened the period of mydriasis, in some cases to eleven or twelve hours. Ordinarily, the pupil returned to normal diameter in about two days.

Atropine Methylnitrate ("Eumydrin"),[23] *1 Per Cent.*—This was the second of the synthetic substances allied to the alkaloids of the belladonna group to be studied. This mydriatic is optically racemic, as is atropine.[17] It is one-tenth as powerful as, and fifty times less toxic than, atropine.[24] As in the case of homatropine hydrobromide, 1 per cent pilocarpine hydrochloride was used to effect miosis, but was unsatisfactory. Since it was not known what complications might be expected with this mydriatic, which is seldom used, younger subjects were tested. The ages ranged from 3 to 32, and 48 patients were tested.

Forty-six patients obtained maximum mydriasis (table) in from twenty-five to one hundred and sixty-five minutes. Curiously, the shortest period of full mydriasis was twenty-five minutes, for a hazel-eyed patient, and the longest period was that for a child aged 3½ years.

While the percentage of dilatation was greater with atropine methylnitrate, it was often necessary to use 2 drops of this mydriatic to obtain

22. Wolf, A. V., and Hodge, H. C.: Effects of Atropine Sulfate, Methylatropine Nitrate and Homatropine Hydrobromide on Adult Human Eyes, Arch. Ophth. **36**:293 (Sept.) 1946.

23. This drug is also known under the names methylatropine, methylatropine nitrate and "metropine."

24. Pyle, W. L.: An International System of Ophthalmic Practice, Philadelphia, P. Blakiston Son & Co., 1912, p. 176.

full mydriasis, whereas when homatropine was used the majority of the pupils dilated fully with only 1 drop.

One exceptional patient went to the theater immediately after the examination and said he saw clearly. However, only about 25 per cent of the patients could read 37 M. type during mydriasis, and an equal number had no light reflex. The pupils usually returned to normal in about two to three days, with 1 exception, of five days.

"Syntropan," 6 Per Cent.—"Syntropan" is the third of the synthetic preparations akin to the belladonna alkaloids to be tested. It is the phosphate salt of the tropic acid ester of a tertiary amino alcohol.[17] It is believed to be one-thousandth as effective as atropine. Like atropine, it is optically racemic. This preparation is not in common use, but recently Bab[25] attempted to popularize this preparation, using a 6 per cent solution. He suggested that the vehicle be of a higher p_H than that of the mydriatics ordinarily used, in order to increase the degree of preservation. Personally, one feels that a mydriatic need not be made up in large quantities if its tendency to deteriorate is its only shortcoming.

Fifty-six patients were examined. The first study on this group was made with 27 patients. The powder is easily soluble, and a 6 per cent solution was at first made up in distilled water. The p_H of this solution was 4.9. The burning of the eye was intense. With the hope of possible alleviation of this stinging sensation, two other solutions were prepared, one in buffer solution of p_H 6.1 and the other in a buffer solution of p_H 7.0. Four patients were tested with the first solution and 4 with the second (p_H 7.0) solution for both eyes. Both preparations were painful. To determine which of the two solutions was least disturbing, 21 patients were tested with a solution of p_H 6.1 in the right eye and a solution of p_H 7.0 in the left eye. As before, both eyes burned to an equal extent. It, however, must be said of 6 per cent "syntropan" that it is a powerful mydriatic, for in spite of the intense burning and the resultant dilution of the mydriatic with tears, 45 of the patients in this group obtained maximum mydriasis in from twenty to one hundred and twenty minutes.

The ages of the patients varied from 4 to 79 years. The greatest majority of patients obtained maximum dilatation after 1 drop was instilled (table). Less than a third of the patients did not have a light reflex under mydriasis, and few could not read 37 M. type, possibly because of photophobia. The increase in tonometric readings averaged about 4 mm., a tension which was still within the high normal limits.

25. Bab, W.: Am. J. Ophth. **29**:728, 1946.

Eucatropine Hydrochloride U. S. P., 1 Per Cent.—Eucatropine was the last of the preparations of the alkaloids of the belladonna group. It is both synthetic and optically racemic. It is an ester of a piperidine derivative and mandelic acid. Sugar [26] expressed the belief that eucatropine does not dilate the pupil to a diameter sufficient to close the canal of Schlemm. Knapp,[27] however, reported 2 cases of glaucoma following the use of 7.5 per cent eucatropine hydrochloride.

All the pupils contracted with pilocarpine in from ten to sixty minutes. The tension showed a slight variation of 3 mm. of mercury. All the patients could read with the pupil dilated, and in all the pupil reacted to light at its maximum dilatation.

Eucatropine Hydrochloride U. S. P., 2 Per Cent.—Of the 61 patients in this group, 44 obtained full mydriasis. In a number of patients this was within forty-five minutes. However, for many patients from 3 to 7 drops of the mydriatic was required for the best dilatation (table). Pilocarpine contracted almost all the pupils. When no pilocarpine was used, two to eight hours elapsed before contraction took place. In 4 patients there was no light reflex, and all patients could read with the eye in mydriasis.

Dibutoline Sulfate, 5 Per Cent.[28]—Under the name dibutoline, Swan and White [29] introduced a new choline ester which has mydriatic qualities. Since the authors [30] expressed the opinion that the dibutoline has an action similar to that of atropine (paresis of the sphincter muscle), and because they compared its action to that of homatropine, it was felt that this new drug could be included in this short study. Further encouragement was given by Peterson and Peterson,[31] who stated the opinion that the drug has a low toxicity even when administered in an increased dose over a prolonged period. The authors claimed that dilatation of the pupil parallels the amount of cycloplegia present. Examination of the present patients revealed no conjunctival irritation or superficial keratitis, such as was claimed by the authors to occur. There were no patients in this group on whom it was possible to check the bactericidal quality of this drug.[32]

It was suggested by the manufacturers that a 1 per cent solution of cocaine would enhance the action of dibutoline and that a single large

26. Sugar, H. S.: Am. J. Ophth. **24**:851, 1941.

27. Knapp, H.: Arch. f. Ophth. **29**:313, 1900.

28. This preparation is dispensed by Merck & Co., Inc., as "ophthalmic solution dibutoline 5%."

29. Swan, K. C., and White, N. G.: J. Pharmacol. & Exper. Therap. **80**:285, 1944.

30. Swan, K. C., and White, N. G.: Proc. Soc. Exper. Biol. & Med. **53**:164, 1943.

31. Peterson, C. G., and Peterson, D. R.: Am. J. Ophth. **84**:236, 1945.

32. Swan, K. C., and White, N. G.: Di-N-Butylcarbaminoylcholine Sulfate, Arch. Ophth. **31**:289 (April) 1944.

dose acted more effectively than repeated smaller doses given over a longer period. But the last two suggestions were not acted on in this study, since it was desired to compare dibutoline in a fair measure with the other mydriatics studied at this time.

One hundred and four patients were examined (table), 99 of whom obtained full mydriasis. The maximum time for spontaneous contraction of the pupil when dibutoline was used was usually less than that for either homatropine or atropine methylnitrate. In the case of each of the three drugs homatropine, atropine methylnitrate and dibutoline the maximum number of drops used to obtained full mydriasis was 3.[33] Only 17 patients would have the intraocular pressure taken; and, while the tensions for these subjects varied somewhat, all were within normal limits. Only 8 patients in this group could read 37 M. type with the pupils fully dilated. In the majority of subjects no light reflex could be obtained. Data on the return of the pupil to normal with and without pilocarpine appear in the table.

"Paredrine Hydrobromide."—"Paredrine hydrobromide" is a sympathomimetic amine and is now introduced to supersede amphetamine, which it resembles in chemical structure. It was first synthesized in 1913, but became popular only within recent years.

"Paredrine Hydrobromide Ophthalmic (1 Per Cent)."—Of the 78 patients (table), 8 were from 70 to 74 years of age. The intraocular pressure varied, but was within the normal limits. Sixty-three of the patients obtained maximum dilatation with "paredrine hydrobromide ophthalmic." Almost all the patients could read 37 M. type under mydriasis when their visual corrections were worn. Only a few patients had no light reflex. It was noted that when pilocarpine hydrochloride, 1 per cent, was instilled in the eye and the pupil became fully contracted, an artificial myopia developed. During this period the patient did not see clearly. It took from one-half hour to a maximum of five hours after instillation of pilocarpine for the myopia to disappear. In the majority of cases, however, the eyes cleared in two hours.

"Paredrine Hydrobromide," 3 Per Cent.—This mydriatic in 3 per cent solution is difficult to obtain in the open market [34] at present, since its use is still in the experimental stage. One hundred and eight patients were tested. The drug was used with patients up to 80 years of age (table). Strangely, only 69 patients obtained full mydriasis, a poorer result than when the 1 per cent solution was used. It is interesting, however, to know that in using "paredrine hydrobromide" of stronger potency, when the patient did get maximum dilatation, the 1 per cent solution accomplished full mydriasis in fifty-two minutes, as

33. One patient, an exception, obtained 4 drops (table).

34. Smith, Kline & French Laboratories supplied this drug.

against forty-nine minutes for the 3 per cent "paredrine hydrobromide." Also, the greatest number of patients who received maximum dilatation with the 3 per cent solution did so with 1 drop of the mydriatic. The eyes cleared in one to five hours, with an average of two and one-half hours. In about one fourth of the patients the pupils did not react to light. When no pilocarpine was instilled, the maximum time at which the pupil contracted was seldom longer than the next morning for patients examined in the afternoon. However, some pupils contracted in from one to three hours. Few patients of this group could read the 37 M. type during mydriasis.

Fortunately, in none of the patients studied did dermatitis venenata develop, as in the experience of Laval,[35] a complication which he claimed was rare.

"Paredrine Hydrobromide Ophthalmic," 1 per cent Versus "Paredrine Hydrobromide," 3 per cent.—For further comparison of the merits of these two mydriatics, 30 patients were studied, the 1 per cent solution being instilled in one eye and the 3 per cent solution in the other eye. Either eye was used for the "paredrine hydrobromide," 3 per cent. With the same number of drops, from one-half to one and one-half hours was required for 6 patients to obtain full dilatation in the eyes receiving the two strengths. In the rest of the patients the pupil of the eye receiving the 3 per cent solution was from 2 mm. larger than to twice the diameter of the pupil of the eye receiving the 1 per cent solution.

GENERAL OBSERVATIONS

In using any of the mydriatics, it was interesting to observe a saturation point, especially in older subjects with hazel or brown eyes. In these eyes no additional amount of mydriatic had any observable effect on the pupil after definite dilatation was obtained. Indeed, in some cases the pupil was even observed to contract.

Twenty-five patients were examined with the same and with other mydriatics on different days. An inconsistency in the action of mydriatics was noted. Thus, a mydriatic used on one day might dilate better, and in less time, than on another day.

The increased activity of a mydriatic in rainy weather was noted in some cases. Whether this is coincidental or whether the atmospheric conditions have any effect on the mydriatic is problematic. It is possible that since the light is not intense on a rainy day, not so much light enters the dilated eye as on a sunny day, even though dark glasses are worn. The action of the mydriatic is therefore undisturbed. It was observed that placing the patient in a dark room after the mydriatic

35. Laval, J.: Allergic Dermatitis and Conjunctivitis from Paredrine Hydrobromide, Arch. Ophth. **26**:585 (Oct.) 1941.

was instilled was more effective in dilating the pupil than using dark glasses in a well lighted room.

"Paredrine Hydrobromide," 1 per Cent Versus Eucatropine Hydrochloride, 2 per Cent.—Since these two mydriatics are relatively mild, it was felt that their comparison might be of value. Twelve patients were tested with 1 drop of one of these mydriatics in one eye and 1 drop of the other drug in the other eye. The ages of the patients ranged from 6 to 64 years. In 3 patients full dilatation was not obtained with either drug. In the other 9 patients the eye which received the "paredrine hydrobromide" was always 3 to 4 mm. wider than the eye which received eucatropine.

Phenylephrine Hydrochloride, 2.5 per Cent.—Phenylephrine ("neosynephrine") hydrochloride is a synthetic sympathomimetic compound, almost analogous therapeutically to epinephrine and ephedrine. It was the last of this group studied. The drug acts by relaxing the constrictor muscles of the pupil and strongly contracting the dilator muscle.

The solution when instilled in the eye stings quite a bit, even though a local anesthetic for ocular pressure has just been instilled.

Forty-four patients were examined in this group. Regardless of how much care was exercised in instilling the mydriatic, there was considerable dilution with tears. In spite of the burning and tearing, 35 patients obtained maximum mydriasis (table).

In many of these patients it appeared that the intraocular pressure coincided with the observations of Heath [36]; that is, the pressures were slightly increased, but were still in the high normal bracket. Pilocarpine effected a return to normal within several hours. This miotic usually caused some irritation and conjunctival injection; these symptoms, coupled with the prior instillation of phenylephrine hydrochloride, made the patient far from comfortable. Many subjects could read during mydriasis. A number had intense photophobia, making it difficult to determine a light reflex.

Glaucoma must be a rare complication when mydriatics are used. In a man aged 47, 7 drops of both 1 and 3 per cent "paredrine hydrobromide" followed by 1 per cent homatropine hydrobromide was used in both eyes over a period of four hours before a 7 mm. pupil was obtained. The tension was taken after each instillation of the mydriatic, without any serious rise of ocular pressure.

In another case, a woman aged 61 had incipient changes in both eyes. She had a shallow chamber; her pupils reacted poorly to light; she did not complain of halos. It was explained to her that the drops might precipitate glaucoma but that a good view of the fundus was of

36. Heath, P.: Neosynephrin Hydrochloride, Arch. Ophth. **16**:839 (Nov.) 1936.

value in diagnosis. She agreed to use of the mydriatic, and 5 drops of phenylephrine was instilled during a period of one hundred and thirty-five minutes. The most that could be obtained was 6 mm. of dilation for both eyes. Her ocular pressure was 4 mm. higher during dilation, but was within normal limits. The phenylephrine did not produce any deleterious effect. She was the only patient who received as many as 5 drops of phenylephrine and yet had no after-effects.

Phenylephrine Hydrochloride, 2.5 per Cent Versus "Paredrine Hydrobromide," 1 and 3 per Cent.—In the comparative study of phenylephrine hydrochloride, 2.5 per cent, and "paredrine hydrobromide," 1 per cent, only 3 subjects were studied. Only 1 subject obtained maximum dilation with both mydriatics. In the other 2 patients maximum dilation was obtained only with phenylephedrine hydrochloride.

It was felt that the 3 per cent "paredrine hydrobromide" was the concentration more comparable to the 2.5 per cent phenylephedrine hydrochloride, and its effect in 14 patients was checked. In 7 patients both drugs obtained maximum dilatation in about the same time. In the other 7, it appeared that the eye which received the 3 per cent paredrine hydrobromide obtained maximum dilation in less time.

Homatropine Hydrobromide and Racéphedrine Hydrochloride.—In 1932 Hartlieb [37] published an article in the German literature describing the use of a mydriatic first suggested by Sattler. This consisted of racemic ephedrine hydrochloride (a dextrolevorotary ephedrine preparation), 0.5 Gm.; homatropine hydrobromide, 0.03 Gm., and distilled water, 10.0 Gm. The advantage given was that the dilatation was obtained in fifteen to twenty minutes and persisted for a few hours. The preparation used in this examination was made up with buffer solution of p_H 7.2 as a vehicle, in place of distilled water.

Then patients were tested with this combination (table). The eyes pained somewhat, and there was redness of varying degrees after instillation of the drops. Unfortunately, all but 1 patient had brown irises and required from 2 to 4 drops of the mydriatic to obtain effect. With the increasing number of drops the pain did not lessen. No patient obtained full dilatation. In this small group there were 4 patients who could get no more than a 6 mm. dilatation. The ages ranged from 7 to 65 years. Three patients took from one hundred to one hundred and thirty-eight minutes to obtain a dilatation of only 6 mm. Most pupils reacted to light, and many could read 37 M. type.

It was felt that by using ephedrine with homatropine or racéphedrine with eucatropine, the preparation might be less irritating. The burning was somewhat less, and a study of more cases could be attempted.

37. Hartlieb, R.: Deutsche med. Wchnschr. **58**:735, 1933; abstracted, Arch Ophth. **10**:134 (July) 1933.

Ephedrine Hydrochloride and Homatropine Hydrobromide.—A solution of ephedrine and homatropine was used with 41 patients. The solution gave a burning sensation, but to a lesser degree than the racéphedrine-homatropine solution. In this group, there were 19 "blue-eyed" patients (table). All but 1 obtained full dilatation. Some pupils did not contract at all with 1 per cent pilocarpine hydrochloride. Thirty-four subjects obtained full dilatation of the pupil. The pupil contracted with 1 per cent pilocarpine hydrochloride sooner than when the racéphedrine-homatropine solution was used.

Racéphedrine Hydrochloride and Eucatropine Hydrochloride.—This solution was the last preparation studied. There were 58 patients in this group. Of the 16 blue-eyed patients, 12 obtained maximum dilatation. It was possible to obtain full dilatation in 40 patients. In the majority the light reflex could be obtained (table), and almost a like number could read 37 M. type at the height of dilatation. There were more or less burning, tearing and conjunctival injection, but less than with the other two mydriatics previously mentioned. Unlike these, pilocarpine contracted the pupil in the majority of cases and in less time.

CYCLOPLEGICS [38]

One of the purposes of this study was to determine how quickly the mydriatics studied could be neutralized by a mild miotic. A cycloplegic property in a mydriatic may prolong this period of neutralization. Possibly the drugs studied were better cycloplegics than was indicated by the results obtained, for the pupil dilated fully and so rapidly in some cases that cycloplegia did not have time to develop fully.

Dibutoline gave the greatest amount of ciliary paralysis, as determined by the Prince rule in conjunction with the correct refraction, to which was added a + 3 D. lens, with the patient looking through a 3 mm. pupil at 37 M. type.

The number of patients who gave evidence of some cycloplegic property in the mydriatic used were as follows:

Mydriatic	No. of Patients
Homatropine hydrochloride, 1%	23
"Syntropan," 6%	9
Atropine methylnitrate, 1%	17
Eucatropine hydrochloride, 1%	None
Eucatropine hydrochloride, 2%	4
Dibutoline sulfate, 5%	51
"Paredrine hydrobromide ophthalmic," 1%	12
"Paredrine hydrobromide," 3%	16
Phenylephedrine, 2.5%	9
Racéphedrine and homatropine	None
Ephedrine and homatropine	6
Racéphedrine and eucatropine	4

38. Dr. Alfred Cowan assisted in evaluation of these data.

Of those drugs which could be neutralized by 1 per cent pilocarpine hydrochloride, dibutoline sulfate took the longest period for contraction of the pupil.

SUMMARY AND CONCLUSION

In this study, twelve mydriatics were checked with regard to their ease of administration, rapidity of action and neutralization by a mild miotic—1 per cent pilocarpine hydrochloride.

Ordinarily, these mydriatics worked more efficiently on cloudy or rainy days, and on patients with blue eyes. But there were exceptions: The same mydriatic on the same patient sometimes took a longer period for complete mydriasis when the patient was tested on different occasions. Some hazel-eyed or brown-eyed patients, as well as some older patients, took less time for mydriasis than "blue-eyed" and younger subjects.

The mydriatics in this study can be divided into drugs which are painful, and which include "syntropan," phenylephredine and the synergists racéphedrine and ephedrine, in solutions of ephedrine and homatropine, racéphedrine and homatropine and racéphedrine and eucatropine, and drugs which are painless and easy to administer.

Homatropine hydrobromide, 1 per cent; atropine methylnitrate, 1 per cent, and dibutoline sulfate, 5 per cent, dilated the pupil in the greatest number of patients. Dibutoline sulfate, 5 per cent, gave definite cycloplegia in association with mydriasis in the greatest number of patients.

"Paredrine hydrobromide ophthalmic" (1 per cent) was less potent than dibutoline sulfate but was quite satisfactory as a mydriatic in a number of cases. Many of the patients with maximum dilatation after instillation of the "paredrine" had a pupillary reflex and could read 37 M. type.

With "paredrine hydrobromide," 3 per cent, the mydriasis was more intense in that fewer drops were necessary and less time elapsed before mydriasis took place. A number of the patients given this solution could not read 37 M. type during mydriasis, nor did they have a light reflex. However, the 3 per cent solution does not have much advantage over the 1 per cent solution of "paredrine hydrobromide" except in the few minutes gained for maximum mydriasis.

Eucatropine hydrobromide, 2 per cent, is the weakest of the nonpainful mydriatics.

When 2 per cent eucatropine hydrochloride, "paredrine hydrobromide ophthalmic" (1 per cent) and 5 per cent dibutoline sulfate were used, their neutralization by 1 per cent pilocarpine hydrochloride with regard to the time interval took place in the order given. The longest period, that for dibutoline, was about four hours. Without miotics, these three mydriatics usually were neutralized spontaneously within twenty-four hours.

With respect to the suggestion of Peterson and Levinson [39] that the patient with glaucoma has a "lability of the cardiovascular-renal system," I had studied previously a larger number of patients with glaucoma. No consistently significant clinical or laboratory evidence was found which would be pathognomonic of glaucoma other than that which would be seen in similar patients of the same age; the diagnosis of "preglaucoma" would, therefore, be suggested by the presence of halos, a shallow anterior chamber and the pupillary reaction, rather than by laboratory studies.

Judging from the large number of older persons studied (of ages from 70 to 80 years) and the large number of drops of the mydriatic used in each case without ill effect, one may conclude that glaucoma is indeed a rare complication of mydriasis. Even in the case of "preglaucoma" in which a mydriatic has mistakenly been used, the rule of never discharging a patient until the pupil is contracted will obviate a disaster, particularly since much more powerful miotics than 1 per cent pilocarpine hydrochloride are available.

37 South Twentieth Street.

39. Peterson, W. F., and Levinson, S. A.: Skin Reactions, Blood Chemistry aad Physical Status of Normal Men and of Clinical Patients, Arch. Path. **9**:151 (Jan.) 1930.

MALIGNANT RETROBULBAR NEURITIS

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IN CHINA one often sees cases which are difficult to explain. Such a one was the case reported here.

CASE 1.—On Sept. 25, 1945, Gen. C. H. H., aged 51, attended a Chinese dinner and drank wine like the other guests. The next morning he did not notice any change in his sight, but in the afternoon vision became impaired and in the evening he was unable to read. Sight in the two eyes was affected equally; everything was blurred, but he could recognize the door. Apparently, there was no central scotoma. On September 27, he was blind, and everything around him was black. He could see the window but not the intersections between the panes. Later, light perception was lost.

The wine was examined, but no toxic substance was found. The Wassermann reaction was negative; repeated Kahn tests gave negative reactions except once, when the reading was 1 plus; the spinal fluid was normal; the blood pressure was 106 systolic and 68 diastolic. Roentgenographic and general examinations failed to reveal any cause. As none of a great variety of treatments had any success, the patient went to the United States and was examined by several prominent ophthalmologists and neurologists. Air introduced into the spinal canal was of no assistance in detection of the cause of blindness. The diagnosis was atrophy of the optic nerve.

On March 27, 1947, I found the papilla of each eye white, the outlines distinct, the arteries narrow, the vessels without sheaths and the lamina cribrosa faintly visible. The pupils were equal and large, although they were sometimes small; they did not respond to light but reacted in convergence. There was complete amaurosis of each eye.

There was a widespread idea that the patient had been poisoned by the wine he drank during the dinner. But as the other guests at the dinner showed no symptoms, and the onset of blurred vision was not until twenty-four hours later, it is not likely that the atrophy of the optic nerve was due to intoxication. Methyl alcohol intoxication, especially, would have produced quite different symptoms and would have acted more quickly.

It is difficult to imagine what disease could have produced such sudden, complete blindness and, later, simple atrophy of both optic nerves; the American physicians who were consulted did not suggest any cause in their reports.

Two other cases which I have recently seen in China suggest an explanation of the sequence of pathologic changes, though they shed no light on the etiologic factors.

CASE 2.—A man aged 25 had onset of pain in the frontal region during the last days of February 1947. The left eye became blind on March 3 and the right eye on March 5. He received injections of neoarsphenamine and later underwent operation in a hospital for "glaucoma" of the right eye. There was no reason to think of an intoxication, as alcohol and medical drugs had not been taken. I saw the patient on March 22.[1] Both eyes were amaurotic, with both pupils very large and without reaction. The right eye presented a basal coloboma of the iris at 12 o'clock. Both eyes showed a normal fundus and normal tension. The Wassermann reaction was positive; the Kahn reaction, 4 plus. The spinal fluid was normal. The blood count was normal; a careful physical examination showed nothing remarkable. The sedimentation rate was normal; the coagulation time was 7 minutes. A roentgenogram showed a normal optic foramen and pansinusitis. The patient was treated with nicotinamide, typhoid vaccine,[2] vitamin B complex, a chiniofon (yatreu®)-casein preparation and penicillin (total dose, 2,400,000 units), given intravenously. On April 3, the middle turbinate bone was removed and a puncture of the sphenoid sinus was made, but no discharge was noted. Six days after his admission the disk became pale, and on April 10 both disks were atrophic and the patient was blind.

CASE 3.[3]—A woman aged 39 became blind in the left eye in three days. She experienced slight pain when she moved the eye or when the eye was touched. When I saw her, the fundus was normal and no light reaction was present. Milk injections and two injections of typhoid vaccine did not produce a temperature higher than 37.5 C. (99.5 F.). After having tried diaphoresis, in vain, two intramuscular injections of 3 cc. of a chiniofon-casein preparation was given. Vision did not return, and the patient left the hospital. Later, a colleague found atrophy of the optic nerve. The fundus of the right eye was normal, and all examinations to find the cause of blindness in the left eye were without results.

In case 2, the disease of the eye differed from that in case 1 only in that the condition did not start at exactly the same time in the two eyes. The right eye became blind two days after the left eye. Moreover, in case 2, the physicians were unable to get a clear picture of the developing pathologic process, and an operation was therefore performed for glaucoma.

Case 3 differed from the first 2 cases in that the blindness attacked only the left eye. The rapid deterioration in vision and the complete loss of the light reflex in a few days were similar in the 3 cases.

Without doubt, these 3 cases illustrate a special type of retrobulbar neuritis, which I shall call malignant retrobulbar neuritis. They were

1. Dr. L. U. Miau, of the Red Cross Hospital, Shanghai, supplied the history in case 2.

2. I was pleased to find fever treatment being used so much for retrobulbar neuritis, as I inaugurated this form of therapy for the disease.

3. Dr. Nie, St. Marie Hospital, Shanghai, furnished the history in case 3.

characterized by sudden onset, by complete disappearance of vision and of the light reflex of the pupils and by resistance to all forms of treatment which are known from experience to be efficient, even in refractory cases of retrobulbar neuritis.

The fact that in all these cases the papilla was normal in the early stages of the disease shows that a poison or toxin could not have been the cause; otherwise, some signs in the central or retinal vessels, especially contraction of the arteries, would certainly have been noted.

I have seen only a few cases of retrobulbar neuritis in which total blindness occurred. Further, in these cases the blindness was binocular, the onset was sudden and light perception disappeared. These ocular symptoms formed part of an encephalomyelitis optica, and the papillae showed prominent edema. In these cases there were several symptoms of general nervous disease, such as paraplegia of the lower extremities, or palsy of the abducens nerve, nystagmus and sudden appearance of the Babinski reflex, in 1 case. The choked disk in these cases of encephalomyelitis was apparently due to location of the focus in the optic nerve close to the lamina cribrosa, so that the associated edema produced swelling of the papilla, with no hemorrhages or white foci of fatty degeneration in the fiber layer.

The aforementioned cases of encephalomyelitis differed from the Chinese cases of malignant retrobulbar neuritis described here in that vision came back to a certain extent after adequate treatment. The accompanying neurologic symptoms in the former cases make the participation of the optic nerve easily understandable. In the cases of malignant retrobulbar neuritis, competent neurologists were unable to find any neurologic symptoms (case 1), demonstrating that in the latter disease a quite different etiologic factor was involved.

This type of malignant retrobulbar neuritis seems to be rare, and I have found no similar case in the literature; only in his comprehensive paper on retrobulbar neuritis did Werner [4] mention the cases of 2 very old patients who became almost totally blind, but both his cases differ from the present ones in the presence of papillitis.

I saw the 3 cases reported here within a few months, and I have the impression that malignant retrobulbar neuritis is not rare in China. However, Dr. Eugene Chen, professor of ophthalmology in West China Union University, Chengtu, Szechuan, told me that he had not seen a case in his practice.

It may be of interest here to give the history of a case of retrobulbar neuritis the symptoms of which resembled those in a severe case seen

4. Werner, L. E.: Tr. Ophth. Soc. U. Kingdom **45**:376, 1945.

in Austria but in which the resistance to energetic treatment was much greater than I have ever encountered.

CASE 4.—A nurse aged 20, at 7 a. m. on Jan. 20, 1947, suddenly began to see everything red in the temporal half of the visual field. Examination four hours later revealed visual acuity of 6/75 in the right eye and 6/6 in the left eye; the papillae were normal. The next day vision had dropped to perception of hand movements at 30 cm. and light sensation at 3 meters, with light projection present only on the temporal side. Tension was normal. Roentgenographic examination of the nasal sinuses and physical examination revealed nothing abnormal. Six days after the onset of symptoms, the patient was given 10 cc. of milk intramuscularly and the same amount on the following day. On the next day she had high fever, and light projection was restored in every direction. Typhoid vaccine was injected intravenously on February 14, 17, 21 and 24, and vision gradually improved to ability to count fingers at 2.5 meters. The visual field apparently was concentrically constricted. On February 28, and on March 4, 8, 15 and 18, typhoid vaccine was again injected. Vision rose to 6/15, and on April 18, after two fever treatments, vision was 6/12 and she read Jaeger test type 4 at 18 cm.

When I saw her, the patient had normal vision in both eyes, and her physician had concluded that she had had hysterical amblyopia. Pupillary reaction was good, and I was informed that it had always been present. The papillae appeared normal on both sides and were of normal color. There was no tenderness of the eye on movement or touch, although for the first three days after onset she had had a slight sensation on the right temple and above the eye during movement.

As essential proof that this case was one of retrobulbar neuritis, with the right eye she saw a red mark 2 cm. in diameter as less red, and as grayer, than with the left eye. Examination of the visual field showed that she did not see red and blue at all when marks 1 cm. in diameter were used. Larger marks were seen as grayer at the periphery than in the center. Small white marks she saw only in an area 8 to 10 cm. at a distance of 35 cm.

It appears that no central scotoma was present, but only a concentrically contracted field. The changes in the value of colors show that in this case there was no hysteria. Apparently, the disturbance was an atypical retrobulbar neuritis with a particularly high resistance to treatment, as many inductions of fever were required for cure and recovery was prolonged. I saw the patient again much later, and there was no change in the color of the disk.[5]

Case 4 forms a transitional type between the malignant and the ordinary type of retrobulbar neuritis. The patient did not at any time lose the light reflex and therefore was never so seriously ill as are patients with the malignant form. It is amazing that she recovered such good vision and that no pallor of the papilla remained. The case

5. Dr. Lewis W. S. Chang, of the Central Hospital, Nanking, furnished me with the history in case 4.

is in particular contrast to cases of multiple sclerosis, in which one may hear nothing of visual disturbance and yet extreme temporal pallor of the disk appears insidiously.

SUMMARY

In 3 cases loss of vision and the light reflex, binocular in 2, developed in two or three days, while the fundi remained normal. Later, primary atrophy of the papilla occurred, and, in spite of energetic treatment, there was not the slightest restoration of vision. For these reasons, I have called this condition "malignant retrobulbar neuritis."

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TECHNIC OF GONIOTOMY FOR CONGENITAL GLAUCOMA

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GONIOTOMY is an operation for stripping or peeling embryonic tissue from the wall of the angle. If the cornea is clear, the operation is performed under direct vision with the aid of a prismatic contact glass specially devised for this purpose. If cloudiness of the cornea prevents the use of the glass, the operation is performed without it.[1]

In recent articles[2] observations on congenital glaucoma and the results obtained during the past ten years with goniotomy performed on 76 eyes presenting congenital glaucoma were published. In 66 of these eyes pressure was normalized and vision was maintained or restored. In 10 eyes the operation was unsuccessful. It is the purpose of the present article to describe the technic of goniotomy, its mode of action and its indications and contraindications. The importance of early diagnosis and prompt operation is stressed. The operation is exacting. It demands teamwork and meticulous attention to detail of technic in order that a high incidence of good results may be obtained and hemorrhage, which may have serious consequences, avoided. Experience with gonioscopy and acquaintance with the variable picture of congenital glaucoma are helpful.

MODE OF ACTION OF GONIOTOMY

In congenital glaucoma the angle presents a characteristic gonioscopic appearance, which shows little individual variation. In 75 of 76 eyes the characteristic condition appeared to consist in an abnormal insertion of the iris by means of adventitious mesoblastic tissue into the wall of the angle anterior to its site of normal insertion. Gonioscopic examination with a hand slit lamp and corneal microscope held in the hand reveals that the iris continues in a horizontal plane until it reaches

Read at the Fifty-Second Annual Meeting of the American Academy of Ophthalmology and Otolaryngology, Chicago, Oct. 16, 1947.

1. The approach to the angle across the anterior chamber was first introduced by de Vincentitis in 1892, and some successes were reported. The method later fell into disuse.

2. Barkan, O.: Operation for Congenital Glaucoma, Am. J. Ophth. **25**:552-568 (May) 1942; Goniotomy for Congenital Glaucoma, ibid. **33**:526-533 (Feb.) 1947.

the posterior surface of the cornea. This is in contrast with a backward dipping of the iris seen in the normal eye, which forms a sinus, or the so-called angle of the anterior chamber. The point of attachment corresponds to the position of the anterior border ring of Schwalbe. The area of transition from the anterior surface of the iris to the posterior surface of the cornea is covered by a gelatinous-looking, semitransparent substance. This area may be so narrow that it barely constitutes a line. It may be wider, in which case the beam of light shows the tissue to be in a plane anterior or axial to the true angle wall, the presence of which can in some cases be discerned in a deeper plane. Delicate arborescenses of uveal meshwork which cross the angle can be seen resting on the semitransparent substance which fills the angle behind them. From this finding, and from the flare of the beam of the

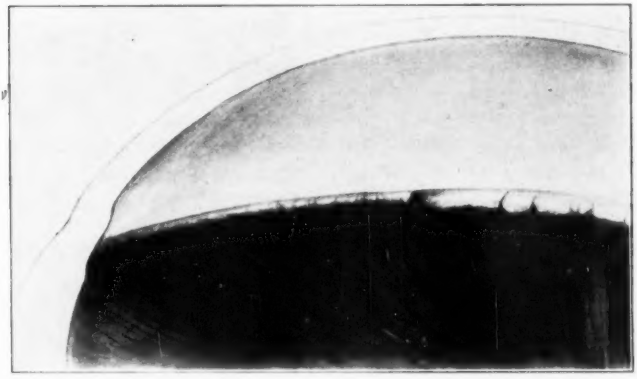

Fig. 1.—Postoperative microgonioscopic appearance at the point of transition between the area on the right, in which the angle has been stripped, and the neighboring, untouched, region.

slit lamp traversing it, it is evident that the angle is not an optically empty space. This becomes especially evident after operation at the point of transition between the area in which the angle has been stripped and the neighboring, untouched, region (fig. 1). The gonioscopic appearance corresponds to that which would be expected from a study of histologic sections of eyes with congenital glaucoma enucleated in the early stages. Gonioscopic study of normal eyes of infants indicates that the chamber angle does not assume an adult appearance until after the age of several months, indicating that the uveal meshwork continues to regress after birth. This appearance can in most cases be distinguished from the pathologic persistence of uveal tissue which is present in congenital glaucoma. Postoperative gonioscopic exami-

nation in the successful cases revealed that the procedure had been effective in stripping from one fourth to one third of the circumference of the filtration angle the persistent embryonic tissue that obstructed it. Figure 1 shows a case in which stripping had resulted in normalization of pressure for nine years, to date. Analysis of the present series of cases suggests that stripping of this amount of the angle is sufficient and is the *sine quo non* of successful normalization of pressure. It also suggests that stripping of only a part of the circumference is adequate to permit the pressure-regulating mechanism to assert itself and permanently to maintain normal tension and function. Since this effect has been observed in individual cases as long as ten years after goniotomy, and since recurrence of increased pressure has been the exception, it appears that the stripped angle does not again become blocked and that the effect is permanent.

In all cases of bilateral glaucoma in this series, and in most cases of the monocular condition. judging from results obtained by stripping the angle and from a comparison of preoperative and postoperative gonioscopic findings, the initial increased pressure appeared to be the result of obstruction of the angle due to arrested regression of the uveal meshwork. Since removal of the persistent embryonic tissue resulted in normalization of pressure, it must be assumed that Schlemm's canal was present. There was no sign that either internal cyclodialysis or external filtration had taken place in any of these cases. It may be concluded, therefore, that the mode of action of goniotomy consists in restoring access of aqueous to Schlemm's canal by removal of obstructing tissue.

In 1 case there was direct gonioscopic evidence of the presence of Schlemm's canal in that portion of the angle from which the obstructing tissue had been removed. This evidence consisted of a pink band lying external to the trabeculum in the position of Schlemm's canal. In the adult this pink band has been shown by Kronfeld [3] to be produced by blood in Schlemm's canal. The presence of Schlemm's canal is suggested by postoperative gonioscopic observations in the aforementioned successful cases. It is confirmed by the analysis of anatomic examinations of 84 specimens taken from eyes on which no operation had been performed, as reported by Anderson.[4] He found that Schlemm's canal was present in 75 per cent of the earliest specimens. No sign of it was found in more than one-half the specimens taken from children over 2½ years of age. He suggests that the canal becomes closed in the later stages as the result of distention of the eyeball and of increased intraocular

3. Kronfeld P. C., and others: Gonioscopic Studies on the Canal of Schlemm, Am. J. Ophth. **25**:1163-1170 (Oct.) 1942.

4. Anderson, J.: Hydrophthalmia or Congenital Glaucoma, London, Cambridge University Press, 1939, p. 151.

pressure. The evidence obtained from these specimens confirms the effectiveness, as judged by gonioscopic examination, of stripping the angle in early congenital glaucoma.

URGENT NEED OF EARLY OPERATION

The mode of action of goniotomy, as explained in the foregoing section, shows the importance of early diagnosis for a successful outcome of operation and explains why the chances of establishing outflow by this procedure may be expected to diminish with the duration of the condition. It is essential to operate early, before prolonged distention of the eyeball has caused obliteration of Schlemm's canal. Other important reasons for early diagnosis and prompt operation are: (1) restoration of vision by means of clearing the cornea, corneal cloudiness being largely reversible in the early stages and becoming progressively less so with the later stages; (2) prevention of amblyopia due to prolonged obstruction of vision by cloudiness of the cornea; (3) prevention of development of permanent scar formation from corneal cloudiness; (4) prevention of injury to the optic nerve caused by prolonged pressure.

In general, it is important to prevent progressive enlargement of the eyeball before distention has produced permanent changes and to encourage development of normal anatomic relations and of physiologic function during the period of growth.

The symptoms of increased intraocular pressure in congenital glaucoma may be present at birth, or their onset may be rapid or sudden during the first few months of infancy. In most cases symptoms are cloudy cornea, photophobia and other signs of irritation and congestion. In the rare cases of slow onset there are no congestive symptoms. Pressure should be measured with the tonometer with the patient under ether anesthesia, which must be deep enough to insure complete relaxation at the moment of measurement in order that the recording of false values may be avoided. The appearance of congestive symptoms is prone to lead to a faulty diagnosis of blepharitis, conjunctivitis or keratitis, causing loss of valuable time and bearing tragic consequences.

The initial cloudiness of the cornea is associated with roughening of the corneal epithelium. This disturbance of the cornea is the chief cause of the irritative symptoms and photophobia, which are further aggravated by exposure to air and light. If the corneal cloudiness is allowed to persist, it is superseded by permanent scarring with associated irregular astigmatism and ensuing amblyopia of greater or less degree.

Glaucomatous atrophy of the optic nerve was the exception in the present series of infants and children. It occurred only in the few cases in which normalization of pressure was unduly delayed. In infants it is not nearly so urgent to protect the optic nerve head from pressure as it is to relieve cloudiness of the cornea.

If soon after its inception increased intraocular pressure is normalized by goniotomy, transparency of the cornea is almost completely restored and maintained, and vision is afforded the opportunity to develop. When this is borne in mind, the urgency of prompt relief of increased pressure is evident.

RESULTS

The results of goniotomy [5] in cases of congenital glaucoma are summarized in the following tabulation.

Number of infants and children	51
Eyes on which goniotomy was performed	76
Eyes successfully treated by goniotomy (pressure normalized; vision maintained or restored)	66
Eyes unsuccessfully treated with goniotomy	10
Eyes to which goniotomy was not applicable	11

It has been my custom to prescribe the use of miotics three times a day for two months after operation. The result of the operation was considered successful when intraocular pressure did not rise higher than 35 mm. of mercury with the McLean tonometer or 21 mm. with the Schiøtz tonometer three months after operation, no miotics having been used during the two weeks preceding measurement of the pressure.

In the successful cases the time which had elapsed since the date of operation varied from six months to ten years. There were recurrences in 2 eyes, mentioned in the next paragraph. The oldest patient (2 eyes) was operated on ten years ago; 5 eyes were operated on seven years ago; 8 eyes, six years ago; 21 eyes, from four to six years ago; 11 eyes, from two to four years ago; 9 eyes, from one to two years ago, and 10 eyes, from three to twelve months ago.

The recurrence of increased pressure which took place in 2 eyes was relieved by a second goniotomy in both instances. In 1 patient, pressure increased in the left eye eight years after operation. In another, pressure increased in the left eye four years after operation. Gonioscopic examination showed that the stripping of the angle had been insufficient.

Repeated operations were necessary in 22 eyes before pressure was permanently normalized. One operation sufficed for each of 45 eyes. In some cases goniotomy was performed four times on each eye before permanent normalization was attained. The ultimate result was excel-

5. Goniotomy in infants and the procedure in adults are two distinct operations, which differ in rationale, technic and effectiveness. In infants, the operation, which has been developed to a relatively satisfactory conclusion, consists in removal of occluding fetal meshwork from the angle. In adults, in whom it has not yet shown a degree of consistent efficacy adequate to recommend its employment except in the occasional case, the objective is to incise the wall of the angle, that is, the trabeculum proper. For this reason, it is suggested that the term goniotomy be applied only to the operation performed on infants, and goniotrabeculotomy, or trabeculotomy, to the procedure carried out on adults.

lent. I believe it is better to err on the side of conservatism, and partially strip the angle with safety on repeated occasions, than to attempt to do an extensive stripping at one operation, at the cost of greater hazard. Cases in which repeated operations were required before permanent normalization was attained are not listed as cases of recurrence.

The operation was performed with the eye under the contact glass on 20 eyes. In all these eyes the goniotomy was successful. Repeated operation is the exception when one operates under the contact glass. In 56 eyes the operation was performed without the contact glass because of corneal cloudiness. On 18 of these eyes repeated operation was necessary. In 8 eyes which had been ineffectively trephined, goniotomy normalized tension.

ADVANTAGES, DISADVANTAGES AND HAZARDS

Striking among the results of goniotomy are absence of cosmetic disfigurement and preservation of a round, central, freely reacting pupil.

A disadvantageous feature of the operation without the glass is the need of repeating the operation in one third of the cases in order that permanent normalization of tension may be obtained. Moreover, a consistently successful performance is associated only with a considerable degree of experience and highly trained assistance.

A hazard of the operation is excessive hemorrhage or iridodialysis if the root of the iris is incised. Vision was lost in 2 eyes early in this series as the result of excessive hemorrhage. Recently 1 eye, in a late, neglected case of a 2½ year old child, was lost as the result of a massive intraocular hemorrhage, which occurred on the sixth postoperative day. As in any other intraocular operation, infection is a possible complication, but it was not encountered in this series. A severe reaction, which could be considered an infective iritis, occurred in 1 case. As always, the operation had been performed on different days, in this instance after an interval of three weeks. The condition cleared after eighteen days, leaving in one eye a small central opacity of the anterior capsule; in the other an anterior adhesion produced eccentricity of the pupil. Tension was normalized, and it is evident that useful vision is developing. In no case has sympathetic ophthalmia yet occurred.

INDICATIONS AND CONTRAINDICATIONS

Goniotomy is indicated in all cases of congenital glaucoma in which increased pressure is the result of obstruction of the angle by persistent embryonic tissue, provided that Schlemm's canal has not been obliterated by, and degenerative changes have not resulted from, prolonged distention of the bulbus. This criterion includes the majority of cases of congenital glaucoma in the early stages. It also includes those cases in which the condition has run a noncongestive course over a long period

and in which the cornea remains clear, the optic nerve undergoes little damage and the bulbus is only moderately enlarged. Good central vision is maintained in these cases. Since the cornea is clear, goniotomy can be performed under direct vision with the aid of the glass, and may be effective even several years after the onset of symptoms. Excellent results were obtained in some of these patients at 4 and 6 years of age, with corneal diameters of 14 mm. However, in general, the sooner the procedure is applied after onset of symptoms, the more effective is the operation in maintaining or restoring vision. Results may be dramatic when the bulbus is in the early congestive phase, associated with cloudiness of the cornea. In such cases the urgent need of early diagnosis and prompt adequate operation can hardly be overemphasized.

Goniotomy is contraindicated in older children whose eyes are in an advanced stage of glaucoma and, as a result of prolonged congestion, show corneal scarring, cloudiness and a corneal diameter of 15 mm. or more. In these enlarged, "buphthalmic" eyes, the danger of hemorrhage is increased because of dilated vessels and establishment of a collateral circulation. Hemorrhage is absorbed more slowly, no doubt owing to the degenerative condition of the eyes and to their altered circulation. Schlemm's canal may be obliterated as a result of the distention.

When permanent obliteration of the canal has taken place, or when repeated goniotomies have proved ineffective, iridencleisis or cyclodiathermy may be tried.

In some rare cases of unilateral congenital glaucoma the condition appears to be the result of other anomalies, such as an aberrant reflection of the stroma of the iris to an insertion at the anterior border ring. The extremely rare cases of narrow angle (iris block) glaucoma[6] in small children do not come within the scope of this article, since goniotomy is not applicable to them.

TECHNIC OF GONIOTOMY

There are two major procedures of goniotomy: If the cornea is clear, goniotomy is performed by direct vision under a prismatic contact glass; if the cornea is cloudy, the operation is done without the glass. The general considerations which the procedures have in common will be treated first.

GENERAL CONSIDERATIONS

Preoperative Measures.—Pediatric examination, including roentgenologic study of the chest for enlarged thymus, is performed in all cases. In the case of infants, the usual diet is maintained up to six hours

6. Barkan, O.: Glaucoma: Classification, Causes, and Surgical Control, Am. J. Ophth. **21**: (Oct.) 1938; An Operative Procedure for Glaucoma of Shallow Chamber Type, Arch. Ophth. **21**:331-345 (Feb.) 1939.

before operation; solution of dextrose is forced up to four hours before operation to avoid dehydration with associated hyperpyrexia. In order that surgical treatment may not be delayed, and since ether may have to be given several times in the course of the following weeks, every effort should be made to prevent the infant from catching cold. Instillations of miotics, preferably neostigmine methylsulfate, 5 per cent, are continued, usually every three hours, while the patient is awake until one and one-half hours before the time of operation. An extra drop is instilled three times at intervals of one-half hour before operation in the eye to be operated on. If circumstances permit, 1 drop of "sulmefrin" (sodium sulfathiazole sesquihydrate plus *dl*-desoxyephedrine) is instilled three times a day for several days before operation.

Anesthesia.—In view of the delicacy of the operation as applied to infants, who may be only a few days or weeks old, and who may show other congenital defects, anesthesia is an important consideration. A preliminary injection of atropine is given forty-five minutes before operation. Ether is administered through a small airway (intrapharyngeal insufflation). A generous supply of oxygen should be assured at all times. While the patient is being prepared, the lids must be kept closed with moist pledgets, but without pressure, since the cornea in congenital glaucoma is extremely susceptible to exposure and to pressure. For the same reason, the heat generated by operating room lamps should be avoided. Anesthesia must be sufficient at the moment of operation to prevent movement of the patient. In children over 6 months of age a small dose of paraldehyde is administered forty-five minutes before operation. Postoperative agitation, which may follow ether anesthesia, is not harmful, since there is only a small, obliquely placed puncture wound, which does not permit egress of ocular contents. Before the patient is draped, the intraocular pressure is taken with a tonometer, the base of which has been sterilized. The corneal diameters are measured, and the condition of the cornea and the size of the pupils are noted. Sometimes the decision as to which eye to operate on can be made only at this time.[7] Then the positions of the patient, operator, assistant, anesthetist and instrument table are arranged accordingly.

Position of Patient.—The infant is placed on a circumcision board: for the right eye, on the center of the operating table; for the left eye, with the head end of the board protruding obliquely from the table. For goniotomy under the glass the eye should be 47 inches (120 cm.) above the floor in order to permit a convenient position for an operator 5 feet 10 inches (178 cm.) in height. For goniotomy without the glass

7. In cases in which the decision has already been made, the taking of the tension is dispensed with as a preliminary procedure, in order to reduce the time of anesthesia.

the patient's eye should be 46 inches (117 cm.) or less above the floor in order that the operator may look vertically down on it. A pillow or towel is placed under the head, bringing it into a horizontal plane. The anesthetist maintains the head in position during the operation.

Position of Operator and His Assistants.—The operator stands on the side of the eye to be operated on: for the right eye, at 11 o'clock; for the left eye, at 4 o'clock. The illuminator, holding a hammer lamp, must be high enough, standing on a platform if necessary, to obtain a good view of the field of operation. He stands on the same side as, and to the right of, the surgeon for the operation with the glass, on the opposite side for operation without the glass. The assistant fixates the bulbus with two Gifford forceps with lock, standing at 3 o'clock for the right eye and behind the head for the left eye. The anesthetist is on the side opposite the operator, for the right eye at 5 o'clock, in order not to interfere with the assistant, who is standing at 3 o'clock.

Magnification.—The operator uses a 2.50 D. sphere hanger over his correction. He wears a binocular head loupe 5.00 D. sphere (Hess head loupe), which he uses in case the anterior chamber is deepened through a corneal puncture made with a discission knife and for goniotomy without the glass. He does not use it for goniotomy with the glass.

Illumination.—The room is in semidarkness. One lamp, situated at some distance from the table and directed away from it, is in readiness for general utility purposes. The field of operation is illuminated by a hammer lamp,[8] which is made of light plastic and is air cooled. It is used in both procedures, but manipulation differs respectively. The illuminator must be familiar with and trained in the procedure. The technic of illumination is especially important in goniotomy by direct vision under the glass and must be carefully rehearsed before the operation.

Instrument Table.—The instrument table is on the side of the eye to be operated on (fig. 2).

Preparation of Patient.—Lashes are clipped (with Stevens scissors and ointment, which is wiped off with cotton spindle after each clip). The face is prepared and the eye irrigated in the usual manner. After the patient is draped, a face mask is applied; this should be of moistened gauze, in order to be easily molded to the region.

GONIOTOMY UNDER THE CONTACT GLASS

Once the glass has been applied, time is the essence of goniotomy. A complete check, therefore, is made beforehand in order to insure that everything is in readiness and in position on the instrument table. The

8. This lamp was demonstrated before the Section on Ophthalmology at the Ninety-Fifth Annual Session of the American Medical Association, San Francisco, July 4, 1946. A description of it is in publication.

speculum is passed through two holes made in a piece of rubber dam 6 inches (15 cm.) square. The height of the assistant and that of the illuminator are checked. Either or both of these persons may require a platform to stand on. The lids are kept closed throughout the preparation. A few minims of epinephrine hydrochloride (1:1,000) is injected into the outer canthus with a no. 30 needle and a 1.5 cc. Luer syringe; after one minute a canthotomy is performed with straight Mayo scissors. The quartz surgical contact glass, which has been cold sterilized, is dried and placed on gauze in a small bowl on the instrument table. The knives (two goniotomy and two discission knives) are now placed on the table, with points toward the operator.

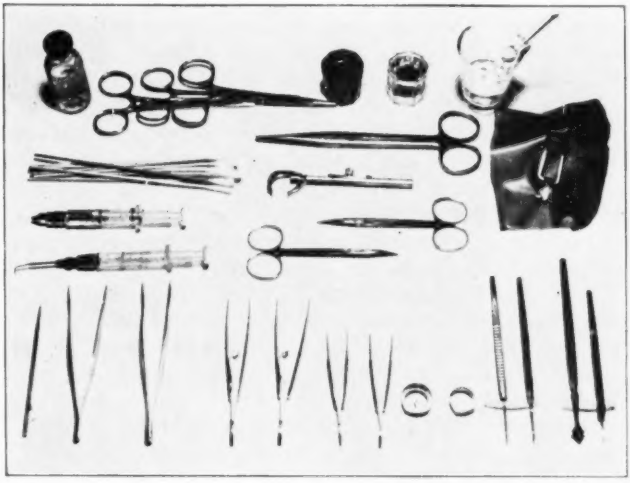

Fig. 2.—Usual setup of tray for goniotomy, with ampule of isotonic solution of sodium chloride; mosquito hemostats; Dappen glass, containing tincture of iodine; Dappen glass containing solution of fluorescein sodium, 1 per cent; medicine glass containing isotonic solution of sodium chloride and glass rod; speculum with rubber dam; applicators; Mayo scissors; Luer-Lok syringe, 2 cc. with no. 30 needle, containing isotonic solution of sodium chloride; caliper; Stevens scissors; lacrimal dilator; splinter forceps; Gifford forceps with lock; Bishop Harman forceps; surgical contact glass (small and large); goniotomy knives; keratome; discission knife, narrow.

The operator stands at 11 o'clock for the right eye and at 4 o'clock for the left eye. The platform on which the illuminator is about to stand is already in position to the operator's right. The instrument table and the surgical nurse are also to the right of the operator. The speculum is now inserted and the rubber dam trimmed, especially on the nasal side. On the temporal side the dam covers the lids, preventing contact

of the knife with them and relieving the operator's mind of this important detail. The cornea is moistened when necessary with isotonic sodium chloride solution U. S. P. applied by means of a glass rod. The eye is fixated by the assistant 3 to 4 mm. posterior to the corneoscleral border at 12 and 6 o'clock, or at the insertions of the vertical muscles, by means of two Gifford forceps with spring lock. He must be mindful not to touch the lock, lest it spring open during the operation. The head and eye are rotated away from the surgeon, who applies the contact glass in the usual manner by injecting isotonic sodium chloride solution between it and the cornea through a curved gold cannula and 1.5 cc. Luer syringe.

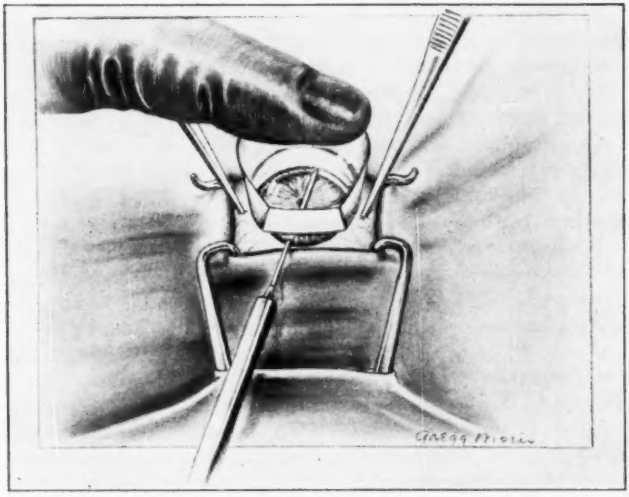

Fig. 3.—Goniotomy, or stripping of the angle under the glass. The root of the iris retracts behind the blade, leaving a white wake behind it, which is the wall of the angle.

When the surgeon is operating on the right eye (fig. 3), the fixator's right hand holds the forceps at 12 o'clock and the left at 6 o'clock. The left hand must be in such a position that it does not obstruct the view of the illuminator as he moves counterclockwise. When the surgeon is operating on the left eye, his right hand is at 6 o'clock and his left at 12 o'clock. Regardless of the side under operation, the fixator, unless tall, should stand on a platform in order to insure visibility of the eye throughout the procedure and to prevent the tendency, arising from poor visibility, to retract or dimple with the forceps. The surgeon supports

the glass with the index finger of his left hand. Two indentations on the glass prevent the finger from slipping. The latter abducts the eye slightly in order to expose a strip of the temporal portion of the cornea 2 or 3 mm. wide, where the puncture is about to be made. With abduction, the eye can be made to offer resistance to the glass when this is pressed more firmly against it by the operator's finger at the moment of puncture, thus preventing ingress of air at this critical moment. The operator applies the end of a cotton applicator previously dipped in tincture of iodine U. S. P. at the intended site of puncture. The goniotomy knife is then passed to him by the instrument nurse. She withdraws the instrument table, and the illuminator assumes his position on the platform immediately to the operator's right.

The illuminator stands on the platform sufficiently far removed from the surgeon to provide room for him to sway counterclockwise during the progress of the incision. The illuminator must stand with feet well apart in order to be able to sway in unison with the counterclockwise movement of the surgeon without having to take a step. He maintains the lamp in contact with the temple of the surgeon, at the same time looking down the top of the shaft of the lamp, so that he may have the same view of the angle and of the blade of the knife as the surgeon. The heads should maintain contact. Perfect synchronization of heads and light is necessary; they must move as one unit. A light on a head band did not give as good results as the technic described.

The eye first having been rotated two hours counterclockwise, puncture is made in the right eye at 10 o'clock, and in the left eye at 4 o'clock, 1 mm. anterior to or axial with the corneoscleral border and oblique, so that the corneal wound is valvelike, or trapdoor-like. At the moment of puncture, extra pressure is exerted by the operator's index finger on the glass in order to prevent ingress of air. Pressure must be exerted in the direction of the optic axis, as tilting of the glass permits entrance of air. For the same reason, dimpling of the sclera with the fixator's forceps must be avoided. The operator guides the knife across the pupil to the opposite side. In traversing the chamber, the knife must always cross the optic axis. When the knife crosses the optic axis, the diameter of the arc described after the opposite angle is engaged will be greater than the diameter of the circumference of the limbus. Therefore, the point of the knife remains engaged. When the knife does not cross the optic axis, the contrary holds true. When an arc smaller than that of the limbus is described, the point of the knife becomes disengaged and too small an incision is made. Moreover, the extra movement of advancing the knife necessary to maintain contact with the wall of the angle is likely to result in picking up iris tissue near the root, with consequent iridodialysis and hemorrhage. The blade is inserted just anterior to the root of the iris and is moved counterclockwise in this plane as long as

visibility permits. This usually amounts to several millimeters, or from one-fourth to one-third the circumference. During this excursion of the blade, the shaft is rotated around its axis in a clockwise direction to encourage a stripping action and to prevent the blade from moving posteriorly out of the intended plane into the dangerous region of the ciliary body. During stripping under the glass, the root of the iris is seen to retract behind the blade, leaving a white wake behind it, which is the wall of the angle (fig. 3). In some cases this has the appearance of a cut piece of parchment paper that drops backward as the incision proceeds. Stripping should be done under complete control and the blade placed immediately above the root of the iris, care being exercised to avoid blood vessels at that site, which in some cases are clearly visible. There may be a slight sensation of grating as the blade proceeds; the fixator may recognize the need of exerting slight resistance. Since picking up the root of the iris causes hemorrhage, it is advisable to start well anterior to the root and to strip or peel off the insertion of the iris from above. When stripping has been completed, the knife is quickly removed, without loss of aqueous in most cases, care being taken to avoid enlarging the puncture wound in the cornea by slight pressure against the back of the blade during its removal. The contact glass and fixating forceps are withdrawn. After a few seconds, a slight oozing of blood of venous color appears in the anterior chamber along the line of stripping; this is absorbed within a few hours. If, after removal of the knife, the pupil should be eccentric, the cornea is tapped near the puncture with a spatula, or the tip of a lacrimal dilator is inserted to prevent adhesion of iris to the inner lip of the wound.

The speculum is removed and the canthatomy closed with surgical gut. Physostigmine ointment, 1 per cent, and sulfathiazole ointment, 10 per cent, are inserted into the conjunctival sac. Binocular pads are applied, the one over the treated eye being covered with a metal shield. The child is placed in bed on the side of operation in order that any blood may settle on the opposite side of the chamber. Arm cuffs are applied. With older children, restrainers may be necessary. Elixir of phenobarbital, 1 drachm (3.7 cc.), may be indicated. In cases of bilateral glaucoma it has been customary after twenty-four hours to instil neostigmine methylsulfate, 5 per cent, in the intact eye and, after forty-eight hours, in the eye operated on; thereafter instillation of drops is continued three times a day in both eyes. Only one eye is operated on at a time.

If the different steps of the procedure have been reviewed before operation, there should be no loss of time at operation, so that once the glass is applied goniotomy is quickly completed.

If goniotomy under the glass is not feasible, the operation is performed without the glass. Operation performed under the contact glass is desirable whenever possible. In the past, various procedures, such

as use of glycerin or hypertonic solution of sodium chloride or retrobulbar injection of epinephrine (1:1,000), have been tried with a view to clearing a cornea which has become cloudy during preoperative maneuvers and application of forceps and the glass without success. Release of a small amount of aqueous through a valvelike corneal puncture made with a Graefe knife was also tried. It cleared the cornea but did not permit of adequate operation under the glass because of complicating circumstances. Recently, a preliminary operative abrasion of a sector of the epithelium prior to application of the contact glass has enabled operation under the glass in cases in which it has heretofore been impossible.

GONIOTOMY WITHOUT THE CONTACT GLASS

The preparatory measures already outlined for goniotomy under the glass are carried out. The precautions mentioned under "General Considerations" are observed. The height of the eye should be such that the operator looks vertically down on it. Illumination is provided by the hammer lamp carried on the end of a rod so that the light falls as nearly vertically from above as possible. The illuminator stands opposite the surgeon, for the right eye at 4 o'clock and for the left eye at 10 o'clock. The rubber dam on the nasal side must be trimmed well back to avoid its casting a shadow on the field of operation. The bulbus is fixated with two forceps held by the assistant, in the same manner as for the operation under the glass. The forceps should be placed vertical to the sclera and must include episcleral fibers in order to permit of resistance or counterpressure on the part of the fixator during stripping. The surgeon applies Bishop Harman forceps at the contralateral limbus, helping to fixate and guide the rotation from there. If the assistant is not sufficiently experienced with this operation, it is best to divide the fixation between him and the surgeon. In this case the surgeon fixates with the Gifford forceps with lock in his left hand at 12 o'clock on the right eye and at 6 o'clock on the left eye, while the assistant fixates with his left hand at 6 o'clock on the right eye and at 12 o'clock on the left eye.

Canthotomy is indicated in most cases. In small infants, in whom the operation is especially delicate, the head is rotated toward the surgeon and the eye slightly abducted in order to bring the nasal limbus into a frontal plane with the surgeon's line of regard. In the case of a greatly enlarged eye this lateral movement is limited because the temporal limbus disappears as the result of even slight abduction.

The puncture in the cornea is made as already described, care being taken that it is oblique (valvelike) in order to encourage retention and reformation of the anterior chamber. It is made on the right eye at 10 o'clock, the eye having first been rotated counterclockwise the equivalent of 2 hours. The blade of the knife crosses the pupil and disappears behind the limbus on the opposite side in a plane just anterior to that of the

iris. As it engages the angle wall and starts its excursion in a counterclockwise direction, slight resistance is felt. Its tip can be seen through the sclera from the outside. Seen through the cornea, the knife appears 0.5 mm. farther anterior than it is in actuality. This appearance must not influence the surgeon to guide his knife farther posteriorly. A posterior position of the blade is the greatest hazard of the operation. It is better to err on the conservative side by maintaining a more anterior plane, at the risk of not stripping the angle. The operation can always be repeated. Rotation of the knife clockwise around its own axis helps to prevent it from being guided or from slipping to a posterior position. Stripping the angle wall is usually associated with a feeling of slight resistance and of grating if the blade is not very sharp. The absence of this feeling is an indication that the blade is too far posterior, and must be avoided. If indicated, the knife may be reversed and the stripping repeated in the opposite direction.

If, on reexamination later, this goniotomy proves to have been insufficient, another stripping can be performed on an adjoining part of the angle after suitable rotation of the eyeball. It has been possible in some cases, as shown by postoperative gonioscopy, to strip the angle over almost one-half its circumference at one sitting.

Picking up the root of the iris and hemorrhage are the only serious complications against which one must guard. It has been found that removal of blood from the anterior chamber by paracentesis and irrigation cannot be adequately accomplished in infants. It is better to be obliged to repeat the operation than to provoke a major hemorrhage by placing the blade too far posterior or by attempting too extensive stripping. If the stripping has been properly placed, a little blood of venous color begins to ooze from several points along the line of stripping a few seconds after removal of the knife. If the head is rotated to the opposite side, the blood coalesces to a thin sheet in the region of the pupil and is seen to stop. If the blood is more arterial in color, is more extensive and follows immediately on the incision, the puncture has been placed more posterior than is desirable. Blood may fill one-half the chamber; it is usually absorbed within twenty-four to forty-eight hours.

The canthotomy wound is sutured, medications are given and dressing is applied, as already outlined in the procedure under the glass.

STRIPPING OF THE ANGLE

In congenital glaucoma, there is an area of from 2 to 3 hours in the circumference of the angle opposite the point of puncture in which it is easiest to do an adequate stripping. Since the position of the puncture is limited on the right eye by the brow and on the left by the cheek bone, a point is chosen as far as possible in a clockwise direction

—for instance, on the right eye at 10:30 o'clock, in order to strike the opposite nasal angle as far clockwise as possible, i.e., at 4:30 o'clock. When the blade has reached 2:30 o'clock, it has covered the area in which stripping can be done under optimum conditions and with least hazard. Postoperative gonioscopy shows that it is often possible to strip a more extensive area, up to 4 hours or more by the clock. Since this cannot be done consistently, and since it is associated with greater hazard of hemorrhage, it is well to consider allocating the area of the first stripping in such a way that another area of the angle, as yet untouched, can be stripped on a second occasion. For this purpose, it is advisable in either procedure, with or without the glass, to start with the eye rotated 2 hours in a counterclockwise direction. Thus, for operation on the right eye the bulbus is rotated in a counterclockwise direction so as to bring the area of the nasal angle between 6 and 3 o'clock within operative reach. The assistant maintains the bulbus in this position and resists, if necessary, the traction of the blade while it strips the angle in a counterclockwise direction. If later examination shows that the result of this procedure was not sufficient to normalize pressure, stripping of a neighboring area of the angle (from 3 to 12 o'clock) may be undertaken. In the latter case the right eye is rotated 2 hours in a clockwise direction to make the area accessible. The puncture is made at 10:30 o'clock, and stripping is performed from 5 to 3 o'clock in the rotated position, which corresponds to 3 to 1 o'clock when the bulbus is in the normal position. It is possible, therefore, by means of two goniotomies, to strip the angle up to one-half its circumference, i.e., from the 6 to the 12 o'clock meridian.

PRELIMINARY DEEPENING OF THE ANTERIOR CHAMBER WITH ISOTONIC SODIUM CHLORIDE SOLUTION

Preliminary deepening of the anterior chamber with isotonic sodium chloride solution U. S. P. may be performed in cases in which operation is done without the glass in order to minimize the hazard of picking up the root of the iris with the tip of the knife. The chamber is not deepened for the operation under the glass; in this case the blade of the knife is guided under direct vision, and therefore picking up the root of the iris, with consequent hemorrhage, can be avoided. Deepening should be considered in the case of infants, especially those between the ages of several days to several weeks because of the relatively shallow chamber and narrow angle. It permits of a more deliberate placement of the stripping in regard to its anteroposterior position. However, it is well to dispense with deepening when possible, as it introduces a delicate technical detail which, if not adequately performed, may result in leakage of aqueous and postponement of the operation. When deepening is employed, great care must be taken in prelaying the corneal puncture.

The bulbus is fixed with a Bishop Harman forceps at the opposite limbus. The cornea is punctured tangentially 1 mm. axial to the corneoscleral border, at 9 o'clock on the right eye and at 3 o'clock on the left eye, with a discission knife, the blade of which has been previously dipped in fluorescein. The wound canal should be at least 3 mm. long. The tip of the knife should barely perforate Descemet's membrane, as observed through a head loupe with a magnification of 5. It may be necessary to tip the knife backward a little in order to perforate this membrane. Care must be taken not to enlarge the puncture on removing the discission knife, lest leakage ensue. The puncture made visible by fluorescein is touched with a dry applicator and then one dipped in tincture of iodine, from which the excess has been removed. With a no. 30 needle (previously drum tested or examined under a loupe to assure its having a perfect point) attached to a 1.5 cc. Luer syringe, saline solution is injected intravenously, the surgeon fixing the bulbus at the contralateral limbus with a Bishop Harman forceps.

AIR GONIOTOMY

If goniotomies have not reduced the pressure sufficiently and gonioscopy shows that further repetition of goniotomy in the nasal portion of the angle is not feasible because of adhesions of the iris or formation of scars, an attempt may be made to perform goniotomy under air in the temporal portion of the angle. This area can be made visible by filling the chamber with air.[9] Since it is difficult consistently to insufflate the whole anterior chamber with air through a corneal puncture, an oblique scleral incision similar to that for cyclodialysis is used and the sterile air injected by means of a curved gold cannula and a small Luer syringe. The eye is then fixated with two Gifford forceps with lock and abducted. The temporal limbus disappears behind the canthus. The operator stands on the opposite side. The knife is passed across the bridge of the infant's nose and the cornea punctured 1 mm. axial to the nasal corneoscleral border. Goniotomy under air, or "air goniotomy," of the temporal portion of the angle is performed. Only a gross picture of the insertion of the root of the iris is discernible through air, owing to the opacities of the cornea, to reflections and to absence of magnification. However, visibility, when combined with familiarity of the angle, may be sufficient to act as a guide to the blade of the knife.

BLUNT DISSECTION

Blunt dissection of the angle with a spatula inserted through a prelaid corneal puncture has been tried in place of stripping or peeling of the

9. Barkan, O.: Goniotomy, Am. J. Ophth. **28**:1133-1134 (Oct.) 1945. Hughes, W. L., Technical Uses of Air in Ophthalmology, Arch. Ophth. **35**:525-540 (May) 1946.

angle with a goniotomy knife. In practice, this has shown no advantage over the present technic with the knife; on the contrary, it appears to encourage adhesion of the root of the iris and closure of the angle.

GONIOTOMY KNIFE [10]

The shaft of the knife is conoid in order to prevent loss of aqueous. Its diameter increases progressively from the tip of the blade to the heel of the shaft. The blade is not too sharp, as it is used to strip or peel, and not to incise, the tip being sharp enough to permit easy puncture of the cornea. The blade offers some resistance during the stripping, which gives the operator a feeling of guidance and deliberate movement.

SUMMARY

Goniotomy, which at the time of this writing had been performed on 76 eyes with infantile glaucoma, preserved useful vision in most cases. In 66 eyes pressure was normalized and vision maintained or restored over periods ranging from one to ten years. In 10 eyes the operation was unsuccessful. When combined with early diagnosis, it provided excellent visual results.

The mode of action of goniotomy is discussed.

The advantages and disadvantages, indications and contraindications of goniotomy are given.

The technic of goniotomy is described.

The importance of early diagnosis and prompt operation is stressed.

490 Post Street.

10. The knife; surgical contact glass, in two sizes, and hammer lamp can be obtained from A. H. Parsons Laboratories, 442 Post Street, San Francisco (2). The knife will be obtainable also from E. Grieshaber, Schaffhausen, Switzerland. Recently specifications for its present form have been sent to V. Mueller and to Storz.

USE OF PROPIONATES IN OPHTHALMOLOGY

A Preliminary Report

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THE PURPOSE of this paper is to acquaint ophthalmologists with a group of physiologic antibiotics, which have hitherto not been used in treatment of ocular infections, and which appear to have certain advantages over medicaments now in general use. This group consists of the lower fatty acids, which occur in the human body. In this preliminary report, the sodium salt of one of these fatty acids, sodium propionate (C_2H_5COONa), was selected for study. While this paper is based essentially on clinical observations, a certain amount of laboratory investigation concerning sodium propionate has been made, and more is in progress. The drug has been used in about 400 cases of infections of the lids, conjunctiva and cornea, and the results so far have proved of sufficient promise to merit further trial.

The use of fatty acids in the treatment of mycotic infections was first introduced by Peck and his co-workers [1] in 1939. These investigators were led to this treatment because their work had convinced them that human perspiration serves as a protective coating against infections generally, and fungous infections in particular. The actual basis for their treatment was their demonstration that sweat was fungicidal and fungistatic because of its content of fatty acids. Previously, Peck and Rosenfeld [2] had shown that the fatty acids inhibited growth of pathogenic fungi and that many of them were even fungicidal in proper concentration. In this excellent piece of work, the fatty acids, beginning with formic acid, with one carbon atom, and going up to capric acid, with ten carbon atoms, as well as the unsaturated undecylenic acid, were studied for their fungicidal powers. It was noted that almost all the sodium salts were less fungicidal than their corresponding acids. Sodium propionate, however, was as effective as propionic acid, while sodium undecylenate was even more effective as a fungicide than its

Read before the New York Academy of Medicine, Section of Ophthalmology, April 19, 1948.

1. Peck, S. M.; Rosenfeld, H.; Leifer, W., and Bierman, W.: Role of Sweat as a Fungicide, Arch. Dermat. & Syph. **39**:126-146 (Jan.) 1939.

2. Peck, S. M., and Rosenfeld, H.: The Effects of Hydrogen-Ion Concentration, Fatty Acids and Vitamin C on the Growth of Fungi, J. Invest. Dermat. **1**:237-265 (Aug.) 1938.

acid, but was otherwise undesirable. Because of this fact, and for other practical considerations, Peck and his associates chose sodium propionate for clinical use, administered topically, and reported gratifying results in the treatment of fungous infections. For purposes of reference, the chemical formulas of the lower fatty acids are listed in table 1.

Following this work, Hoffman, Schweitzer and Dalby,[3] of the Ward Baking Company, demonstrated, in 1939, that many of the fatty acids and their salts are fungistatic for certain nonpathogenic fungi. Many of the large baking companies now incorporate sodium propionate in bread dough and cake batter to inhibit the growth of mold. This practically universal practice and other experimental data indicate that sodium propionate is not highly toxic. The retarding effect of propionates on molds in dairy products has also been under investigation by a number of workers.

TABLE 1.—*Chemical Formulas of the Lower Fatty Acids**

Carbon Atoms		
1	Formic acid	$HCOOH$
2	Acetic acid	$CH_3.COOH$
3	Propionic acid	$CH_3.CH_2.COOH$
4	Butyric acid	$CH_3(CH_2)_2.COOH$
5	Valeric acid	$CH_3(CH_2)_3.COOH$
6	Caproic acid	$CH_3(CH_2)_4.COOH$
7	N-heptylic acid	$CH_3(CH_2)_5.COOH$
8	Caprylic acid	$CH_3(CH_2)_6.COOH$
9	Pelargonic acid	$CH_3(CH_2)_7.COOH$
10	Capric acid	$CH_3(CH_2)_8.COOH$
11	Undecylenic acid (unsaturated)	$CH_3(CH_2)_7.CH = CH.COOH$

* Each succeeding saturated fatty acid is obtained by adding an additional CH_2 (methyl) radical.

In 1943 Keeney [4] reported extensive laboratory studies on the fungistatic activity of sodium propionate for pathogenic fungi. It is interesting to observe that Candida albicans, Torula histolytica, Coccidioides immitis and Blastomyces, all pathogenic yeasts which at times involve the ocular tissues, as well as Actinomyces bovis, were among the fungi whose growth was inhibited by sodium propionate. Keeney also made clinical investigations with the drug. Continuing these studies with the fatty acids, Keeney and his associates,[5] in 1944, extended their investigations to

3. Hoffman, C.; Schweitzer, T. R., and Dalby, G.: Fungistatic Properties of the Fatty Acids and Possible Biochemical Significance, Food Research **4**:539-545 (Nov.-Dec.) 1939.

4. Keeney, E. L.: The Fungistatic and Fungicidal Effect of Sodium Propionate on Common Pathogens, Bull. Johns Hopkins Hosp. **73**:379-390 (Nov.) 1943.

5. Keeney, E. L.; Ajello, L.; Broyles, E. N., and Lankford, E.: Propionate and Undecylenate Ointments in the Treatment of Tinea Pedis and an in Vitro Comparison of Their Fungistatic and Anti-Bacterial Effects with Other Ointments, Bull. Johns Hopkins Hosp. **75**:417-439 (Dec.) 1944.

include the antibacterial effects of these drugs. They then apparently demonstrated that a propionate–propionic acid ointment mixture, containing 16.4 per cent sodium propionate and 3.6 per cent propionic acid, was superior in its antibacterial effect on Staphylococcus aureus (coagulase positive) and on beta hemolytic streptococcus to 10 per cent ammoniated mercury, 5 per cent sulfathiazole and 0.5 per cent tyrothrycin, as well as benzoic and salicylic acids. When compared with a penicillin ointment containing 500 units of the substance per gram, the propionate–propionic acid mixture was found to be as effective against the beta hemolytic streptococcus but less effective against Stap. aureus. They also showed that while the propionic acid component played the major role in fungistasis and a lesser role in bacteriostasis, the sodium propionate portion was also of great importance in these effects, by breaking down when in contact with the skin to form propionic acid. Thus, Keeney and his co-workers confirmed the observations of Peck and his group that fatty acid therapy was of value with fungous infections and, in addition, apparently demonstrated an unanticipated antibacterial action. The fact that one preparation was exceedingly effective against both fungi and bacteria was held to be extraordinary.

Further dermatologic reports on fatty acid therapy have confirmed the clinical value of these drugs and have stressed the infrequency of drug sensitization as well. The therapy has also proved effective in eradicating dandruff, which is considered by some to be related to blepharitis. Intramuscular injections of sodium undecylenate have been administered, with no ill effects.[6] Intravenous injections of sodium caprylate have been used successfully in the treatment of endocarditis due to C. albicans.[7] Propionate jelly has been used successfully for mycotic vulvovaginitis[8]; relief from pruritus vulvae occurred in three days. Propionates have proved valuable in treatment of rectal conditions. An excellent summary of the entire subject of fatty acid therapy was published in 1947 by Peck and Russ,[6] who also demonstrated the efficacy of propionate-caprylate mixtures, both in vitro and in vivo, in this paper.

It is interesting to note that fatty acids are among the ether extractives of the conjunctiva and probably occur in the secretion of the meibomian glands; they must also be present in the glands of Moll in the lid margin, because they are modified sweat glands, as well as in the other sweat glands of the eyelids.

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6. Peck, S. M., and Russ, W. R.: Propionate-Caprylate Mixtures in the Treatment of Dermatomycoses, Arch. Dermat. & Syph. **56**:601-613 (Nov.) 1947.

7. Peck, S. M.: Personal communication to the author.

8. Alter, R. L.; Jones, C. P., and Carter, B.: The Treatment of Mycotic Vulvovaginitis with Proprionate Vaginal Jelly, Am. J. Obst. & Gynec. **53**:241-244 (Feb.) 1947.

The investigations reported in this paper were undertaken at the suggestion of Dr. Samuel M. Peck. It was felt that nontoxic compounds occurring in the human body, with demonstrated fungistatic as well as bacteriostatic powers, which caused little or no irritation when used locally, might be of value in treatment of external diseases of the eyes.

LABORATORY DATA

The laboratory studies were made in collaboration with Dr. Peck.

Figure 1 shows the bacteriostatic effect of a 0.1 per cent solution of sodium propionate on a suspension of Staph. aureus (coagulase positive) containing 4,000 organisms per cubic centimeter. After two hours a strong bacteriostatic effect was apparent. In a similar experiment, no growth at all was noted after three hours. Figure 2 demonstrates the

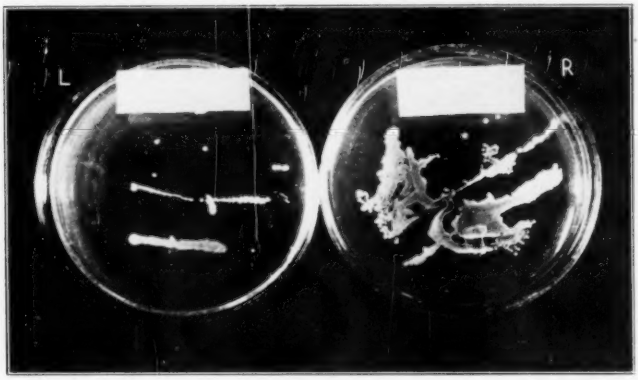

Fig. 1.—Bacteriostatic effect of a 0.1 per solution of sodium propionate on a suspension of Staph. aureus (coagulase positive), containing 4,000 organisms per cubic centimeter. The picture on the right shows the growth when streaked after fifteen minutes' contact; the picture on the left shows the growth after two hours' contact.

antibacterial effect of 0.1 cc. of a 5 per cent solution of sodium propionate, at p_H 7.3, against coagulase-positive Staph. aureus obtained from a patient with severe acute conjunctivitis, by means of the agar cup plate technic. The clear area about the cup represents the area of inhibition. Figure 3 *A* demonstrates the antibacterial effect against beta hemolytic streptococcus, and *B* shows well the effect against Streptococcus viridans. Figure 4 *A* shows that sodium propionate has an antibacterial effect on Pseudomonas aeruginosa (Bacillus pyocyaneus), a finding of interest to ophthalmologists; *B* demonstrates its effectiveness against Bacillus subtilis, usually not an ocular pathogen. Figure 5 demonstrates how the antibacterial effect of sodium propionate increases greatly when used

in stronger solution or when 1 per cent sodium caprylate is added to it. Solutions of 5, 10, 15 and 20 per cent sodium propionate are used both alone and with 1 per cent sodium caprylate added to each. The agar

Fig. 2.—Bacteriostatic effect of 5 per cent sodium propionate at p_H 7.3 on Staph. aureus (coagulase positive), with agar cup plate technic. The clear area about the cup represents the area of inhibition.

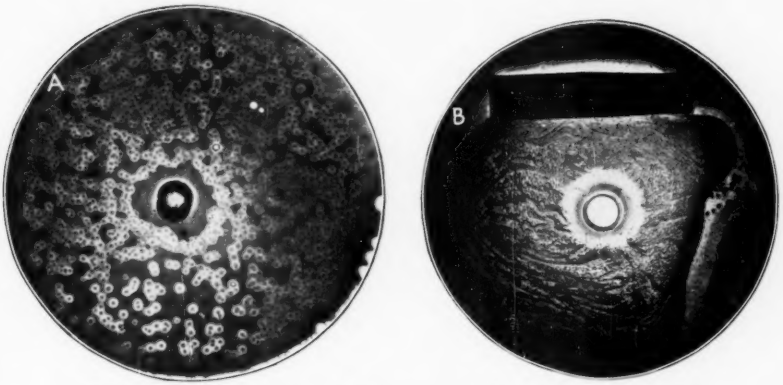

Fig. 3.—Bacteriostatic effect of 5 per cent sodium propionate at p_H 7.3 on (*A*) beta hemolytic streptococcus; on (*B*) Strep. viridans.

plates in this experiment contain an unusually heavy seeding of coagulase-positive Staph. aureus.

It is to be noted that these experiments were carried out with the same solution as that used in the clinical studies, that is, 5 per cent sodium propionate at p_H 7.3. The antibacterial and fungistatic effects of the drug increase greatly as the p_H becomes more acid.

CLINICAL RESULTS

For clinical investigations, a 5 per cent solution of sodium propionate, buffered to p_H 7.3, was used.[9] In addition, an ointment containing the drug in 2 per cent concentration was also tried out, and a jelly containing 5 per cent sodium propionate is being tested. The ointment proved slightly irritating in some cases and is therefore not entirely satisfactory

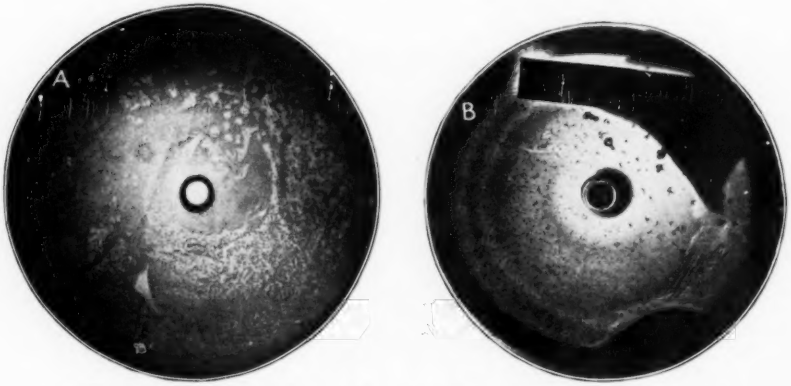

Fig. 4.—Bacteriostatic effect of 5 per cent sodium propionate at p_H 7.3 (*A*) on Ps. aeruginosa and (*B*) on B. subtilis.

TABLE 2.—*Clinical Results in Treatment of Acute Conjunctivitis with 5 Per Cent Sodium Propionate*

Type of Conjunctivitis	Total No. of Cases	Improvement		
		Pronounced	Some	None
Acute Bacterial				
Staphylococcus A	53	47	4	2
Pneumococcus	6	6	..	..
Hemophilus influenzae	1	1	..	..
No culture or sterile culture	25	23	..	2
Acute Viral				
Béal's type	2	..	..	2
Epidemic keratoconjunctivitis	5	..	..	5

at present. The jelly is better tolerated. Clinical observations were made on private patients, in Dr. R. Townley Paton's clinic at the

9. The solution of sodium propionate used in the clinical studies was supplied by the Mycoloid Laboratories, Little Falls, N. J.

Manhattan Eye, Ear and Throat Hospital and in Dr. Henry Minsky's service at the Mount Sinai Hospital. As the evaluation of clinical results is at best difficult, and of little worth unless exact diagnoses are made, bacteriologic studies were carried out whenever possible. These included differential cultures, secretion smears and epithelial scrapings of the conjunctiva and lid margins. Staphylococci were studied for

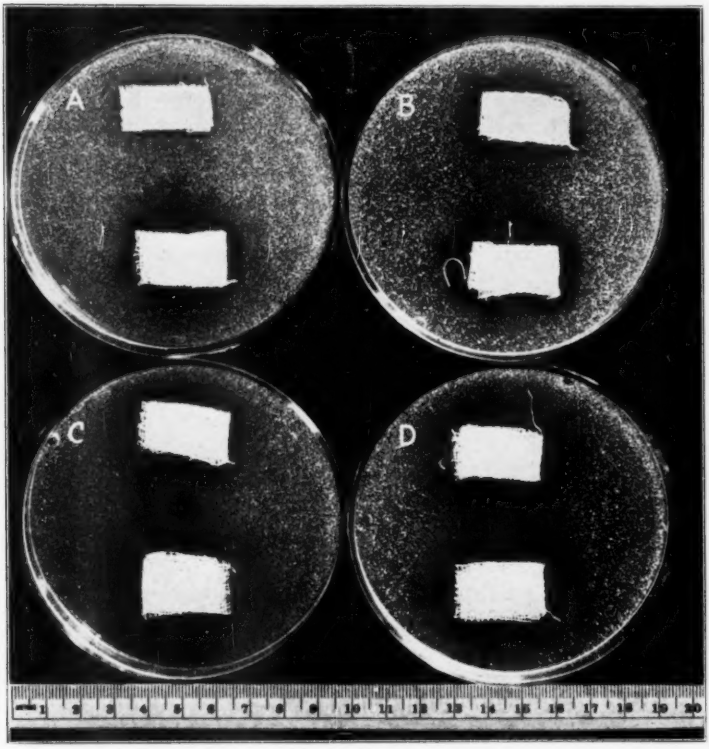

Fig. 5.—Bacteriostatic effects of higher concentrations of sodium propionate at p_H 7.0 and propionate-caprylate mixtures on Staph. aureus (coagulase positive). In plate *A*, the upper gauze contains 5 per cent sodium propionate; in plate *B*, 10 per cent sodium propionate; in plate *C*, 15 per cent sodium propionate, and in plate *D*, 20 per cent sodium propionate. The lower piece of gauze in each plate contains the same concentration of sodium propionate as the upper gauze plus 1 per cent sodium caprylate.

hemolysis, the coagulase reaction and the fermentation of mannitol. No attempt was made to select favorable patients for treatment; every patient seen was treated with sodium propionate.

Acute Conjunctivitis.—Sixty patients with acute mucopurulent or purulent conjunctivitis whose cultures yielded pathogens were treated with 5 per cent sodium propionate solution every two or three hours. As indicated in table 2, the disease in 53 patients was due to Staphylococcus A,[9a] the toxic variety. Of these 53 patients, 47 became practically well in forty-eight to ninety-six hours. Four patients improved but needed special treatment, such as local applications of silver nitrate, to expedite their recovery. Six patients with pneumococcic conjunctivitis became well in forty-eight to seventy-two hours. A patient with an especially severe form, due to influenza, did well with propionate therapy. Of 25 patients with acute mucopurulent conjunctivitis for whom cultures were not made, or whose cultures were sterile, the condition cleared up rapidly in 23; in 2 it was not helped significantly by the drug. In some of these patients the disease was milder than the average severe form in the series whose cultures grew pathogens.

In 2 patients with acute follicular conjunctivitis (Béal type) the infection did not respond objectively to sodium propionate. The patients

TABLE 3.—*Clinical Results in Treatment of Chronic Conjunctivitis with 5 Per Cent Sodium Propionate*

Etiologic Factor	Total No. of Cases	Improvement		
		Pronounced	Some	None
Staph. A	16	14	1	1
Pneumococcus	1	1	..	..
Streptothrix	1	..	1	..
Lacrimal conjunctivitis	3	..	3	..
Keratoconjunctivitis sicca	1	..	1	..

appeared more comfortable while using it, but the course was not shortened. In 5 patients with epidemic keratoconjunctivitis, likewise, the benefit was only subjective. Corneal opacities developed.

Chronic Conjunctivitis.—In the series of 17 cases of chronic catarrhal conjunctivitis with positive cultures, unassociated with significant blepharitis, of the 16 cases in which Staph. A was the causative agent, the patients were greatly improved, if not well, in 14. In the other 2 cases longer treatment was required. In these cases, incidentally, the infection did not respond to sulfacetimide and penicillin. In 1 case of pneumococcic conjunctivitis improvement was pronounced (table 3). In 3 cases of lacrimal conjunctivitis the conjunctiva became cleaner on the use of propionates. In 1 case of streptotrichal canaliculitis, the associated mucopurulent conjunctivitis improved under treatment with propionates, even before removal of the concretions. In a case of keratoconjunctivitis sicca associated with Sjögren's syndrome, considerable

9a. The term Staphylococcus A is used to denote either Staph. aureus or a Staphylococcus albus which has been shown by tests to be toxic.

improvement, both subjective and objective, occurred with the frequent use of sodium propionate. The corneal erosions did not improve, however. In another, milder, case, the condition also improved.

Chronic Infections of the Lid.—Chronic blepharoconjunctivitis, which has been stated by Thygeson [10] to be due either to a toxic staphylococcus or to the yeast Pityrosporum ovale or to a combination of the two, seemed to offer an exceptionally good field for trial of the fatty acids. Not only may the administration of a therapeutic agent which is fungistatic, as well as antistaphylococcic, be useful in itself, but the well known chronicity of the condition makes eventual drug sensitivity and bacterial resistance not unusual. Treatment was started with sodium propionate, in the form of drops of the 5 per cent solution and the 2 per cent ointment. As soon as the initial effect of this drug was noted, the treatment was broadened in the severest cases to include applications of silver

TABLE 4.—*Clinical Results in Treatment of Chronic Infections of the Lid with 5 Per Cent Sodium Propionate*

	Total No. of Cases	Improvement		
		Pronounced	Some	None
Blepharoconjunctivitis				
Staph. A	27	19	6	2
Staph. A and yeast	12	10	2	..
Infectious eczematoid dermatitis				
Staph. A	5	3	2	..
Meibomitis with recurrent chalazions				
Staph. A	3	3	..	..
No pathogen found	1	..	..	1

nitrate and injections of staphylococcus toxoid. It is perhaps unnecessary to emphasize that the use of a drug by the patient alone usually will not suffice in a case of chronic blepharoconjunctivitis of any severity. As is well known, the condition generally requires considerable local treatment by the ophthalmologist and desensitization by injections in severe cases if toxic staphylococci are present. Of the patients who did well, at least one-half had previously used penicillin and sulfonamide drugs but could not tolerate them for long periods. Several patients whom these drugs had not helped at all did remarkably well with propionates from the start.

As shown in table 4, in all the 39 cases of chronic blepharoconjunctivitis Staph. A was the causative agent. In addition, in 12 cases yeast organisms were found in significant numbers in scrapings of the lid margins. In the latter group the response appeared to be somewhat better than in the group in which no yeasts were found. Follow-up scrapings in the group with yeast infections revealed notable diminu-

10. Thygeson, P.: Etiology and Treatment of Blepharitis, Arch. Ophth. **36**: 445-477 (Oct.) 1946.

tion in most cases, in some even absence of the yeast organisms after treatment. However, in at least 1 case, with clinical recovery, great numbers of yeast organisms were still present. In 1 of the 2 cases of failure in the entire series, penicillin and the sulfonamide drugs did not help either; in the other case, sulfacetimide definitely improved the condition temporarily but could not be tolerated later.

Of 5 cases of infectious eczematoid staphylococcic dermatitis, great improvement occurred in 3, and some improvement, but not complete, was noted in 2.

In all 3 cases of chronic meibomitis with recurrent chalazions in which Staph. A was grown, the condition improved to a notable degree, and it responded to the complete type of treatment used with blepharitis. In the other case, in which no pathogen was found, the infection was not helped by propionates or by any of the antibiotics, but did respond to roentgen therapy.

TABLE 5.—*Clinical Results in Treatment of Corneal Infections with 5 Per Cent Sodium Propionate*

	Total No. of Cases	Improvement		
		Pronounced	Some	None
Catarrhal ulcers				
Staph. A	6	4	1	1
Culture sterile	2	1	..	1
Rosacea keratoconjunctivitis	2	2	..	..
Dendritic keratitis	1	..	..	1
Mooren's serpiginous ulcer	1	..	..	1

Corneal Infections.—Of 8 cases of catarrhal corneal ulcers observed, Staph. A was isolated from the conjunctiva in 6 (table 5). Of these 6 cases, striking improvement with propionates occurred in 4, some improvement in 1 and no improvement in 1. In the last case the ulcer did not respond to penicillin either, but required use of the thermaphore. In 1 case in which the culture was sterile, a good response also occurred. In the other, a case of recurrent ulcer, the condition was not significantly influenced by either penicillin or propionates and may have had an allergic origin. In those cases in which the propionates did not help objectively, they seemed to alleviate subjective symptoms.

In 2 cases of rosacea keratitis with intense conjunctival inflammation, considerable improvement occurred with sodium propionate.

In a case of herpetic (dendritic) keratitis sodium propionate was of no benefit. However, after extensive cauterization with iodine, propionate jelly was found to be soothing and did not appear to interfere with healing. In a case of Mooren's serpiginous ulcer the lesion was entirely uninfluenced by the drug.

Miscellaneous Conditions.—In addition to the 174 cases just discussed, all of which were carefully classified etiologically, sodium pro-

pionate was used in about 200 cases of chronic conjunctivitis of varying degrees of severity in which either cultures and scrapings contained no pathogen or cultures were not made because the condition was not severe enough to warrant it. In many of these cases, significant objective improvement was noted; moreover, in many others the patient noted subjective improvement and requested more of the medicine. The fact that a number of them had not reacted as well to the usual medications prescribed lent more importance to this favorable subjective response. This effect has also been noted in the use of propionates on other mucous membranes, as well as dermatologically.

In a case of an extensive burn of the cornea with lye, the patient was comfortable with the use of sodium propionate drops, and epithelization did not appear retarded.

Allergy.—In the entire series of 400 cases, a mild reaction suggestive of sensitivity developed in 1 case. In some cases transient minor irritation developed, but the use of the drug was continued.

CONCLUSIONS

Preliminary studies appear to indicate that sodium propionate may be of value in the treatment of external diseases of the eyes. It seems efficacious in the usual types of acute bacterial conjunctivitis encountered and plays a useful role in the treatment of chronic blepharoconjunctivitis and other types of chronic infections of the lid. It is a nontoxic, nonirritating, physiologic drug, which apparently may be tolerated for months without the development of drug sensitivity, except in rare instances. Most patients find it soothing to use. Although its antibacterial spectrum has not yet been completely delineated, there is evidence, both clinical and laboratory, that the bacteria which generally cause ocular infections are sensitive to sodium propionate. It appears to be of value in some cases in which the sulfonamide compounds and antibiotics no longer are effective. The reverse also occurs. It is ineffective in treatment of virus infections of the eye.

In a self-limited infection, such as acute bacterial conjunctivitis, good results will be obtained from many medicaments. Since the advent of the sulfonamide drugs and antibiotics, one is likely to forget, for example, the value of silver, both mild silver protein U.S.P. and silver nitrate, in treatment of this condition. Just what is used is of less moment in conditions of this type, except of course in the hyperacute types of infection, such as those due to the gonococcus or the meningococcus. In the case of the average acute infection almost any thing will be of help sooner or later. However, sodium propionate appears efficacious in about as short an interval as any other drug used and seems to have no unpleasant sequelae. Furthermore, owing to its effect on staphylococci, its use

should diminish the tendency of acute staphylococic conjunctivitis to become chronic.

In cases of the chronic type of blepharoconjunctivitis the choice of medication becomes of greater importance. In this condition, it would appear that the use of sodium propionate may be of particular value. Although Keeney found a 20 per cent propionate–propionic acid ointment to be more effective than the sulfonamide compounds, and only slightly less effective than penicillin, in vitro, the 5 per cent solution of sodium propionate at p_H 7.3 was less effective in vitro. However, in vivo, 5 per cent sodium propionate is usually equally effective, even sometimes superior, probably owing to its prolonged action. The clinical shortcomings of the sulfonamide drugs and the antibiotics, including penicillin, streptomycin and tyrothricin, became more apparent in treatment of chronic blepharoconjunctivitis. The frequent allergies that occur, and the development of bacterial resistance, which may persist for years, are among the important drawbacks to their prolonged use. Furthermore, these drugs have little effect against most fungi, including yeast. Thus, the combination of fungistatic and antibacterial action that sodium propionate appears to offer suggests that further studies concerning it may be worth while, even if it proves to be of value merely as another supplementary method of treatment or when combined with other drugs. The fact that sodium propionate can be safely and effectively used after the sulfonamide drugs and the antibiotics have been tried, and have caused irritation, is alone of great therapeutic usefulness.

The favorable results noted occurred with a 5 per cent solution of sodium propionate buffered to p_H 7.3. As the drug is more effective in vitro at an acid p_H, and as concentrations higher than 5 per cent appear to be tolerated in the eye and have greater antibacterial effect, studies are now in progress to determine what strength and what p_H will prove the most effective clinically. A combination of propionates with caprylates is also being tried.

Further studies of the scope of usefulness of fatty acid derivatives administered internally or parenterally may indicate value in fungous infections of all the ocular tissues. The use of the drugs as preservatives for ocular medicaments may also be found advantageous.

SUMMARY

The lower fatty acids are nontoxic, physiologic antibiotics and fungicides. Sodium propionate, a fatty acid derivative, was used clinically in about 400 cases of conjunctivitis, blepharitis and keratitis. It has proved efficacious and nonirritating, especially in treatment of chronic conditions, and shows promise in its use as a supplement or substitute for other therapeutic agents now in general use.

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Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

THE VARIATIONS IN THE SYSTEM OF THE TRUNKS OF THE POSTERIOR CILIARY ARTERIES. T. SUDAKEVITCH, Brit. J. Ophth. **31:** 738 (Dec.) 1947.

The author notes the absence in the textbooks of ophthalmology of a special section to describe the constant anastomoses of the ophthalmic artery, or, of more importance, the pathologic changes in the eye connected with them, notwithstanding that there is no lack of scientific investigation of these anastomoses; they have been well known for a long time. A review of the known variations in the system of the ophthalmic artery is then given, followed by the author's anatomic studies. Special attention is given to the two most essential points—the system of the ophthalmic artery in the orbit itself and its part within the skull. What the author believes to be heretofore undescribed is the fact that the ophthalmic artery forms an angle when it passes around the optic nerve, before it enters the foramen opticum—first below it and externally, then to the superior external margin and then toward the medial side, crossing the optic nerve from above. This angle exists nearly always. As a rarity it may be absent—for instance, when the ophthalmic artery is situated below and to the medial side of the optic nerve. The angle is not always the same, not only in different persons, but even in the same person. In childhood and adolescence the angle is always sharp; after the age of 24 it is chiefly perpendicular, and after 40 years of age it is obtuse. The sharp angle may be preserved, in single instances, up to senility, but it is not seen after the age of 65.

The author thinks that no one has previously described this angle, but the variations in it that are due to age change the correlations of various parts of the ophthalmic artery, and so the direction of the pulse wave, for the artery in this particular spot is always firmly fixed to the membranes of the optic nerve and cannot straighten its angle each time in relation to the pulse wave. It is for this reason that the angle changes with age from a sharp to an obtuse one.

The article does not lend itself well to abstracting. It is accompanied with 28 illustrations.

W. ZENTMAYER.

STUDY OF PIGMENT CELLS OF THE CHOROID IN THE CHICK EMBRYO. J. NORDMANN and R. STOLL, Ophthalmologica **114:** 99 (Aug.) 1947.

In chick embryos, the pigment cells of the choroid can be recognized from the tenth day after fertilization. These cells are independent of the pigment layer of the retina from the beginning, and some of the cells show a close relationship to the choroidal nerve endings. The authors point out that pigmentary elements are usually developed in close relationship to such innervation.

F. H. ADLER.

Conjunctiva

FURTHER RESEARCH ON PANNUS FOLLICULARIS TRACHOMATOSUS. C. PASCHEFF, Am. J. Ophth. **30:** 1001 (Aug.) 1947.

Pascheff concludes that pannus is a lymphofollicular hyperplastic manifestation or reaction of the limbal conjunctiva and has the same histologic structure and evolution as that in trachoma verum. The best way to avoid recurrence is to transplant skin instead of mucous membrane.

W. S. REESE.

CONJUNCTIVITIS WITH MEMBRANE FORMATION. M. J. HOGAN, Am. J. Ophth. **30:** 1495 (Dec.) 1947.

Hogan presents a classification of types of conjunctivitis in which membranes develop and discusses the nature and pathogenesis of this membrane formation. Diphtheroids from 100 cases of external ocular disease were studied for pathogenicity. Attempts to enhance the pathogenicity of diphtheroids by utilizing the protective effect of mucin were unsuccessful, as were attempts to produce diphtheroid infections of the conjunctiva by lowering the resistance of the conjunctiva with diphtheria toxin and trauma.

W. S. REESE.

Cornea and Sclera

ANTITOXIN TREATMENT OF STAPHYLOCOCCIC CORNEAL ULCERATION. J. H. ALLEN, Am. J. Ophth. **30:** 987 (Aug.) 1947.

Allen concludes that administration of antitoxin is of practical value as a temporary measure in the treatment of severe staphylococcic infections until active immunization, chemotherapy or antibiotic therapy can become effective.

W. S. REESE.

GRAVE MANIFESTATIONS OF GOLD THERAPY IN THE CORNEA AND SKIN. U. AZZOLINI, Riv. di oftal. **1:** 361, 1946.

The author describes a case in which tuberculous manifestations were favorably influenced over several years by two series of gold treatments. At the start of the third series, grave changes occurred in both corneas and the skin of the face, associated with a high degree of eosinophilia.

After reviewing the modern concept of allergy and parallergy and considering the reaction which appeared in the cornea and the skin after the administration of a gold salt, the author asserts that a local sensitivity develops and is due to the sum total of tissue changes of a parallergic variety brought on by successive series of gold therapy. The eosinophilia places this reaction in the group of pseudoidiosyncrasies.

G. B. BIETTI—J. J. LO PRESTI.

BLOOD STAINING OF THE CORNEA. W. A. MANSCHOT, Ophthalmologica **113:** 203 (April) 1947.

Five cases of blood staining of the cornea are reported, in which histologic sections were made and certain histochemical tests were carried out. The author points out that blood staining of the cornea may

occur as a ring, instead of the disk generally reported. Blood staining of the cornea occurs only after trauma or glaucoma, so that it is probable that preceding damage of the endothelium and of Descemet's membrane is necessary for its appearance. In almost all of the cases which have been studied anatomically, highly refractile oval bodies are observed within the cornea. These were first described by Treacher Collins. The author found that they are digested by trypsin, and hence he believes that they consist of the crystalline precipitation of the protein bodies of hemoglobin. The pigment observed in the protoplasm of the corneal cells contains iron as well as fat, so that it is obvious that both hemosiderin and lipofuscin are present.

F. H. ADLER.

Experimental Pathology

INFLUENCE OF LOCAL ARTERIAL BLOOD PRESSURE ON AQUEOUS HUMOUR AND INTRAOCULAR PRESSURE: AN EXPERIMENTAL STUDY OF THE MECHANISMS MAINTAINING INTRAOCULAR PRESSURE. E. BÁRÁNY, Acta ophth. **24:** 337, 1946; **25:** 81, 1947.

The author summarizes his study as follows: During the first twenty-four hours after closure of the carotid artery, the intraocular pressure and the blood pressure keep a level which does not differ from that attained one hour after closure of the artery. During the subsequent days a slight additional fall in blood pressure, and possibly also in intraocular pressure, is followed by a return to normal. This return to normal is much more rapid in the case of the intraocular pressure than in that of the blood pressure. Moreover, the intraocular pressure returns to complete normality in spite of the persistence of a considerable deficit in blood pressure. This return could be interpreted as the result of a slow-acting regulation. However, the fact as the intraocular pressure and the regulatory mechanisms completely recovers, in spite of persistent deficit in blood pressure, supports the view that the observed regulation is an instance of a more general adaptation of the vascular bed to low blood presure.

O. P. PERKINS.

General

ERUPTIVE FEVER WITH INVOLVEMENT OF THE RESPIRATORY TRACT, CONJUNCTIVITIS, STOMATITIS AND BALANITIS. S. N. SOLL, Arch. Int. Med. **79:** 475 (May) 1947.

This syndrome has been described under a variety of terms, such as eruptive fever with stomatitis and ophthalmia, erythema multiforme exudativum of Hebra, erythema or herpes iris conjunctivae, ectodermosis erosiva pluriorificialis and Stevens-Johnson syndrome. Soll reports observations on 20 cases occurring in military personnel. The disease is acute, probably infectious, self limited and febrile. Prodromal symptoms referable to the respiratory tract are followed by lesions of the skin and mucous membrane of the mucocutaneous junctions, characterized by vesicles and pseudomembranes and accompanied frequently with fever, and occasionally with bronchopneumonia. In determining the pathogenesis, bacteriologic observations are of no significance. There is no evidence that ingestion of drugs is a factor. Because of the prodromal symptoms referable to the respiratory tract and generalized manifesta-

tions, the disease is regarded as air borne, systemic and probably due to a virus. The various names proposed and used are misleading in that they direct attention almost exclusively to the skin. Erythema exudativum multiforme means little in cases in which dermatologic lesions do not occur. The term "erythema pluriorificialis exudativum" is better in that it refers also to the orifices of the body, but it is too long and has only descriptive meaning. Until the causative agent is found, appropriate naming of the disease will not be possible. W. ZENTMAYER.

General Diseases

SYNDROME OF SJÖGREN. E. HARTMANN and S. DE SEZE, Bull. Soc. d'opht. de Paris, January-February 1947, p. 10.

According to the authors, these are the first 2 cases of Sjögren's syndrome seen in France. The triad of symptoms consist of evolutionary chronic arthritis, hyposecretion of salivary glands and secondary alterations of the conjunctiva and cornea with hyposecretion of the lacrimal glands and keratoconjunctivitis sicca. In both cases in which the syndrome was present the lower cul-de-sac was red and presented many follicles. A mucopurulent secretion revealed Staphylococcus albus. The cornea was cloudy and showed streaks which stained wtih fluorescein. The lacrimal secretion was diminished. There were a slight elevation of general temperature, partial anemia, and increase in polymorphonuclear cells. L. L. MAYER.

RELATION OF CUTANEOUS DISEASES AND OCULAR LESIONS. M. ARTOM, Rev. paulista de med. **29:** 261 (Oct.) 1946.

When one is considering the relation of the skin and the eyes, the pathologic condition of the eyelids and that of the globe should be studied separately. Quincke's angioneurotic edema and toxicodermal edemas, especially those caused by hair dyes, commonly involve the eyelids. Blepharitis establishes the patient's seborrheic condition. Dermatoses, such as zoster, lupus erythematosus, infections, burns, vaccinia pustules, trauma and mycosis, are of special importance when seen on the lids, as they often cause cicatricial ectropion. Xanthelasma is also of interest in connection with the cutaneous metabolism of the lipids. Syphilis and leprosy cause many ocular manifestations. Cutaneous tuberculosis is generally accompanied with ocular alterations, and phlyctenular keratitis is often observed in the several varieties of tuberculosis, especially the papulonecrotic type. Some cutaneous avitaminoses are characterized by ocular symptoms, such as the corneal lesions associated with pellagra, xerophthalmia and day blindness, which, in children, often accompany cutaneous manifestations characteristic of avitaminosis, and conjunctival and retinal hemorrhages, which are a part of the cutaneous syndrome of scurvy and avitaminosis C. Congenital cataract, which frequently accompanies the genodermatoses, that is, the alterations of the tegument and its adnexa caused by hereditary disturbances of the germ plasma, should be especially mentioned. Congenital cataract is also noted in association with Pringle's nevus and Recklinghausen's neurofibromatosis. Retinal angioid streaks, abnormalities of motility, exophthalmos and the condition of the fundus of the eye are considered. M. E. ALVARO.

Glaucoma

THE PROBLEM OF GLAUCOMA. JAN VANYSEK, Brit. J. Ophth. **30:** 742 (Dec.) 1946.

The author agrees that the comparison of glaucoma and edema is justified to a great degree. In an effort to find out whether there is a parallel between edema and glaucoma, he reviews present views on edema. One can easily find a parallel between inflammatory edema and glaucomatous iritis. In the typical secondary glaucoma which occurs in cases of thrombosis of the central vein of the retina, he finds a parallel with cardiac edema. For primary glaucoma he finds a parallel in Quincke's edema. In view of this concept of the pathogenesis of glaucoma, it would seem possible to control glaucoma in a conservative way by restoring the imbalance of the vegetative nervous system, paralyzing the sympathetic fibers and removing accentuating causes.

W. ZENTMAYER.

GENERAL AND LOCAL NEUROVEGETATIVE SYSTEM IN PATIENTS WITH PRIMARY GLAUCOMA. MIGUEL DE TORRES LUCENA, Rev. españ. de oto-neuro-oftal. y neurocir. **4:** 166 (Sept.-Oct.) 1945.

De Torres Lucena first studies the general tonus of the vegetative system in his patients with primary glaucoma. He subjects the patient to conditions similar to those necessary for a determination of the basal metabolic rate, repeatedly takes the patient's pulse in a clinostatic and an orthostatic position, injects neutral atropine sulfate, 0.25 mg., intravenously and repeats the injection until a complete block of the vagal system is obtained. The frequency of the pulse at this point will indicate the sympathetic tonus, and its difference from the normal pulse rate gives the parasympathetic tonus. He found a constant dystonia (imbalance of the two parts of the vegetative system) in his glaucomatous patients: amphotony (increased tonus of both parts of the vegetative system) with acute congestive glaucoma and a mixed type with chronic simple glaucoma. He gives the following figures: for patients with acute congestive glaucoma: amphotony in 65.51 per cent, a hypervagotonic-hyposympathicotonic state in 24.13 per cent, a hypersympathicotonic-hypovagotonic state in 6.89 per cent and a hyposympathicotonic state in 3.44 per cent; for chronic simple glaucoma: a hypervagotonic hyposympathicotonic state for 50 per cent, a hypersympathicotonic-hypovagotonic state for 35.71 per cent, a hypersympathicotonic state in 7.14 per cent and a hypovagotonic state in 7.14 per cent.

Once his patient's vagal system was blocked, he determined the local tonus of the ocular sympathetic system by measuring the size of the pupil and taking the intraocular tension. In normal subjects no change in tension was observed, but in patients with primary glaucoma he obtained hypertension in 47.72 per cent, hypotension in 36.36 per cent and unaltered tension in 15.9 per cent. He considers these changes in tension an expression of a local dystonia of the ocular vegetative system, which is of sympathicotonic type in 50 per cent and of parasympathicotonic type in 30 per cent of patients with acute congestive glaucoma. He reached similar conclusions for simple chronic glaucoma.

ESCAPINI HUMBERTO.

Injuries

THE FUNDUS IN FRESH GUNSHOT WOUNDS OF THE SKULL. S. ZBARSKY, J. Ophth. **1:** 43, 1946.

Five hundred and thirty service men with trauma of the skull were observed; of these the meninges were injured in 80, the bones of the skull in 100 and the soft tissue of the brain in 350. The fundus was examined two to three days after the injury and every four or five days thereafter for three or four weeks, or as long as the patient remained in the hospital. Zbarsky summarized his observations and reached the following conclusions: Primary edema of the brain, even in cases of severe trauma of the skull, did not effect the optic nerve, the changes in which were observed on the third day. Papilledema appeared in cases of severe edema or infection of the brain. Of the cases of injury to the soft tissues of the head, the optic nerve remained normal in 100 per cent; of cases of injury of the bones of the skull, a pathologic condition of the fundus was found in 20 per cent, and in cases of injury of the brain, papilledema was observed in about 60 per cent. Papilledema was seen in 20 per cent of cases of traumatic abscess of the brain. A normal fundus usually indicated a favorable course of the injury to the skull and brain. The prolonged presence of papilledema in cases of prolapse of the brain is a poor prognostic sign. The picture of the fundus has an important diagnostic and prognostic value and will aid in deciding whether to perform an emergency operation or to evacuate the injured man from the Army base hospital to the rear.

Case histories illustrate the article.

O. SITCHEVSKA.

Lacrimal Apparatus

TECHNICAL CONTRIBUTIONS TO DACRYOCYSTORHINOSTOMY. B. CARRERAS DURAN, Arch. Soc. oftal. hispano-am. **6:** 1134 (Nov.) 1946.

The author points out the danger of injury to the nasal mucous membrane when, in dacryocystorhinostomy, the opening in the bone is made with the trephine. To avoid this complication, he injects by the nasal route 1 or 1.5 cc. of an oily solution of procaine hydrochloride between the nasal mucous membrane and the bone. Since the ophthalmologist is not familiar with the intranasal anatomy, the author has devised a simple instrument to point to the region where the injection is to be made. It consists merely of a metal rod, of the same length as the needle of the syringe, attached to the base of the needle and running parallel to it. The needle extends into the nose, and the rod remains on the outside. When the tip of the rod reaches the region of the lacrimal sac, the liquid is injected under the intranasal mucous membrane.

The danger of hemorrhage during or after dacryocystorhinostomy is minimized by making the incision in the nasal mucous membrane with a fine electric knife, instead of with the ordinary scalpel. The article is illustrated with drawings.

H. F. CARRASQUILLO.

AN ADVANTAGEOUS MODIFICATION OF DACRYOCYSTORHINOSTOMY. M. BURCH BARRAQUER, Arch. Soc. oftal. hispano-am. **6:** 1150 (Nov.) 1946.

One of the most important causes of failure of dacryocystorhinostomy is closure of the opening made into the nasal cavity when the posterior

and anterior lines of sutures between the wall of the sac and the nasal mucous membrane come in contact and fuse in healing. To avoid this, the author has used to advantage in 29 cases a V-shaped silk suture, which, by being passed through the skin, nasal mucous membrane and wall of the sac and being brought out again through the skin, approximates the anterior wall of the sac and the anterior lip of the opening into nasal mucous membrane and brings them in contact with the superficial tissues when the ends of the thread are tied on the surface of the skin. In this way, the approximation of the suture of the posterior wall of the sac and the nasal mucous membrane and that of the anterior wall of the sac and the nasal mucous membrane is avoided.

The author uses a special technic for the incision in the skin and the dissection of the underlying muscle fibers and tendons in exposing the lacrimal sac in order to obtain the best results with his suture. At the same time, he achieves better cosmetic results.

H. F. CARRASQUILLO.

Methods of Examination

INVESTIGATION IN VARIABLE MONOCHROMATIC LIGHT OF THE OUTER VESSELS OF THE EYE. T. KORNERUP, Acta ophth. **24:** 423, 1946.

The author's summary follows:

The pericorneal injection in eyes showing inflammatory changes was examined by the author in variable monochromatic light.

The so-called LS value, being the mean between the long wavelength (L) at which the vascular network close to the corneal limbus disappears and the short wavelength (S) at which it reappears, could thus be determined.

This value varies during the course of inflammatory diseases of the eye. A clinically observable, continuously proceeding improvement is accompanied with steadily falling LS values; a deterioration, by rising LS values, without any tendency to fall.

In several cases, as shown by the graphs, a change which was not yet clinically observable was predicted by a change in the LS values.

O. P. PERKINS.

Ocular Muscles

THE PSYCHOLOGY OF THE SQUINTER. A. E. STROMBERG, Am. J. Ophth. **30:** 601 (May) 1947.

Stromberg concludes that the success of orthoptic training is determined by the desire and will of the patient to learn and that the development of this will depends on the teaching ability of the orthoptist. These patients must always be regarded as individual persons, not cases.

W. S. REESE.

WHICH SQUINTS RESPOND BEST TO ORTHOPTIC TREATMENT? E. ROTH, Am. J. Ophth. **30:** 748 (June) 1947.

Roth states that purely accommodative squints and those with a large convergence insufficiency factor offer a good prognosis, but that squints with a pure, or even a primary, divergence excess factor must be treated surgically.

W. S. REESE.

THE PLACE OF PERIPHERAL FUSION IN ORTHOPTICS. H. M. BURIAN, Am. J. Ophth. **30:** 1005 (Aug.) 1947.

Burian discusses the various types and degrees of fusion and emphasizes the importance of studying the sensory behavior of the peripheral, as well as the central, areas and the training potentialities of the periphery of the retina.

W. S. REESE.

OPTIC NEURITIS AND OCULOMOTOR PARALYSIS. A. GRIGNOLO, Boll. d'ocul. **24:** 61, 1945.

The author describes the case of a woman aged 48 in whom, after a typical eruption of herpes zoster ophthalmicus involving the first and second branches of the trigeminus nerve, there appeared three days later ptosis of the upper lid, paralysis of the superior rectus muscle, herpetic keratitis and retrobulbar neuritis, with complete loss of central vision and pallor of the nerve head. With the passing of time the paralysis of the levator and superior rectus muscles disappeared, but vision remained affected, owing to well established atrophy of the optic nerve.

G. B. BIETTI.

Orbit, Eyeball and Accessory Sinuses

EXOPHTHALMOS IN RELATION TO ORBITAL TUMORS: REPORT OF EIGHT CASES. S. B. FORBES, South. M. J. **40:** 206 (March) 1947.

Eight cases of unilateral exophthalmos resulting from orbital tumors are reported. The series comprised a lipoma, an extraorbital squamous cell carcinoma involving the posterior part of the orbital plate, an ethmoidal pyocele, an ethmoidal mucocele and a primary pseudotumor, 1 case each; orbital hemangioma, 2 cases, and tremendous hypertrophy, edema and infiltration of the muscular cone and extraocular muscles, particularly the inferior rectus, 1 case. In the case of the primary pseudotumor, the exophthalmos disappeared after irradiation. In all the remaining cases surgical treatment was successful. The Krönlein operation was used for the removal of the hemangioma in both cases. However, the author experienced a great deal of difficulty with this approach in 1 of these cases, in which the hemangioma was situated in the extreme posterior inner aspect of the orbit; he states the belief that an approach through the brow or a transfrontal approach through the orbital roof would be easier and safer in cases of tumor in this location. An original method of delivering a large hemangioma *en masse* is described.

C. P. GRANT.

PSEUDOSINUSITIS OF THE NEWBORN AND THE YOUNG INFANT. G. OFFRET and J. MEAUX, Arch. d'opht. **7:** 250, 1947.

This is a long, detailed discussion, with the citation of 2 cases. The development of the teeth and sinuses in the baby is presented in some detail. As a result of their investigation, the authors express the belief that the condition (pseudosinusitis) is primarily osteomyelitis of the superior maxilla. They state that the idea of a sinal origin in children should be abandoned. Formerly the prognosis was unfavorable, the

mortality reaching as high as from 70 to 80 per cent of cases. Within recent years surgical intervention has taken a secondary place in the treatment, which now consists largely in the use of the sulfonamide drugs and penicillin. The sulfonamide compounds had already reduced the mortality to between 50 and 30 per cent. An extensive bibliography is appended.

S. B. MARLOW.

Physiology

STUDIES ON THE PHYSIOLOGY OF THE EYE USING TRACER SUBSTANCES: I. THE STEADY-STATE RATIO OF SODIUM BETWEEN PLASMA AND AQUEOUS HUMOR IN THE GUINEA PIG. R. O. SCHOLZ, D. B. COWIE and W. S. WILDE, Am. J. Ophth. **30:** 1513 (Dec.) 1947.

Scholz, Cowie and Wilde used radioactive sodium as a tracer to study the distribution of sodium between the plasma and the aqueous and between the aqueous and the lens in the guinea pig. The steady state ratio—the sodium plasma-sodium aqueous ratio—was found to be 0.920.

W. S. REESE.

Physiology

STUDIES ON THE PHYSIOLOGY OF THE EYE USING TRACER SUBSTANCES: II. THE TURNOVER RATE OF SODIUM IN AQUEOUS HUMOR OF THE GUINEA PIG. W. S. WILDE, R. O. SCHOLZ and D. B. COWIE, Am. J. Ophth. **30:** 1516 (Dec.) 1947.

Wilde, Scholz and Cowie compare the direct, or linear, method with the exponential method of calculating from tracer data the turn-over rate of a constituent in the aqueous humor of the eye. They find that the exponential method is the more accurate.

W. S. REESE.

STUDIES ON THE OUTFLOW PRESSURE OF AQUEOUS IN HUMAN BEINGS. H. GOLDMAN, Ophthalmologica **114:** 81 (Aug.) 1947.

The difference between the intraocular pressure and the pressure in the episcleral veins is the outflow pressure of the aqueous humor. This determines the rate of flow of the aqueous humor out of the eye. The author has sought to measure this outflow pressure by determining the pressure of the special spring balance put on the middle of the cornea which is just able to broaden the aqueous thread in a laminated episcleral vein, that is, in one of the aqueous veins visible in the conjunctiva and episclera. This pressure he calls the "apparent outflow pressure," and it is always increased during high pressure in a case of glaucoma. This apparent outflow pressure is increased in simple glaucoma, even if the tension of the eye has been rendered normal by drugs. On the other hand, in cases of acute glaucoma in which the pressure is normalized by drugs, this outflow pressure is normal. In cases of chronic congestive glaucoma in which the tension is normalized by drugs, it is sometimes found elevated and sometimes normal. Goldman believes that in 90 per cent of persons one can see the aqueous veins. Therefore, it seems possible to find out very early states of simple glaucoma by a rapid procedure, namely, the measurement of the apparent outflow pressure.

F. H. ADLER.

Refraction and Accommodation

THE SODIUM-VAPOR LAMP AND ITS USE FOR REFRACTION. S. VAN WIEN, Am. J. Ophth. **30:** 1527 (Dec.) 1947.

Van Wien enumerates the advantages of sodium light for funduscopy, but he found no essential difference between it and polychromatic light in retinoscopy, nor did it improve visual acuity. With cycloplegia, print could be read at closer distance with white light, and this may be additional proof for so-called paradoxic accommodation.

W. S. REESE.

EFFECT OF VISUAL TRAINING ON EXISTING MYOPIA. H. R. HILDRETH, W. H. MEINBERG, B. MILDER, L. T. POST and T. E. SANDERS, Am. J. Ophth. **30:** 1563 (Dec.) 1947.

The authors conclude that training improves the vision of some myopic persons, although there is no change in the refractive error. A recheck after an interval of fifteen to twenty-three months showed that 5 of 11 of the patients in their series retained the improvement.

W. S. REESE.

Retina and Optic Nerve

TREATMENT OF RETINITIS PIGMENTOSA WITH SPECIAL REFERENCE TO THE FILATOV METHOD. D. M. GORDON, Am. J. Ophth. **30:** 565 (May) 1947.

Gordon reviews the various measures used in treatment of retinitis pigmentosa, giving attention to the Filatov method of tissue therapy. Work done at the New York Hospital with this method is presented as a guide to other investigators.

W. S. REESE.

EPIDEMIC RETROBULBAR NEURITIS IN THE PHILIPPINES DURING THE JAPANESE OCCUPATION. G. DEOCAMPO, C. V. YAMBAO, P. J. MAÑAGAS and C. L. SEVILLA, Am. J. Ophth. **30:** 698 (June) 1947.

Data are given on 38 cases of retrobulbar neuritis, 2 of which are cited in detail as typical. The diagnosis and treatment are discussed. Predisposing factors are thought to be (1) individual and racial weaknesses of the nervous system, or "soil"; (2) emotional strain of the war, and (3) focal infection, indulgence in tobacco and alcohol, lactation and other conditions.

W. S. REESE.

RETINITIS PROLIFERANS AND TUBERCULOSIS. G. GIMÉNEZ RUÍZ, Arch. Soc. oftal. hispano-am. **7:** 226 (March) 1947.

Giménez Ruiz presents 2 cases of proliferating retinitis in patients with tuberculosis. He assumes that the latter was the causative factor. One of the patients, a man aged 28, with active pulmonary tuberculosis, had current hemorrhages in the vitreous, and from these retinitis proliferans developed. The other patient, a man aged 23, showed increased density and areas of calcification in both pulmonary hiluses and chronically enlarged cervical lymph nodes. He also had repeated hemorrhages into the vitreous, which later became organized.

The author contends that preretinal hemorrhages must occur in order that retinitis proliferans may develop. The hemorrhages are preceded by phlebitis of the retinal veins, usually of tuberculous nature.

H. F. CARRASQUILLO.

RETINAL PERIPHLEBITIS. G. CARDILLO, Rassegna ital. d'ottal. **13:** 56, 1946.

The author describes a case in which lesions of the fundus typical of periphlebitis were followed by severe retinal hemorrhage, without involving the vitreous, and a completely benign course, with conservation of visual function. The changes were only in the periphery of the fundus. In discussing the etiology, the author ruled out thromboangiitis obliterans, focus of infection in the tonsils and hemorrhagic diathesis, and demonstrated its tuberculous nature by a strongly positive reaction to the intradermal test with tuberculin, by the constitutional habitus of the patient and by the regression of the perivenous exudates and the appearance of less serious hemorrhages after the intradermal reaction to turberculin. The infection seems to be hematogenous. A cure with tuberculin could not be attained, but treatment with calcium, arsenic and ascorbic acid showed favorable response when autohemotherapy was added at the height of the hemorrhagic episodes.

G. B. BIETTI—J. J. LO PRESTI.

Trachoma

ELECTROMETRIC VARIATIONS IN THE TISSUE p_H IN TRACHOMA. P. VANCEA, Arch. d'opht. **7:** 156, 1947.

The author presents evidence indicating that the trachoma virus produces an increased acidity of the conjunctival tissues and that this acidity returns to normal as soon as the trachomatous foci are thrown off. The clinical cure is preceded by a reestablishment of the acid-base equilibrium, a reestablishment which can be considered a true biochemical cure and which is evident early as compared with the clinical condition.

S. B. MARLOW.

Tumors

PIGMENTED TUMORS. A. B. REESE, Am. J. Ophth. **30: 537** (May) 1947.

Reese, in this de Schweinitz Lecture, discusses tumors which seem to differ genetically, histologically and clinically but have one factor in common, namely, pigment. This tends to dominate the histologic and clinical picture and overshadows or excludes other fundamental differences. Therefore he suggests that the term "melanoma" be discarded, and he offers alternative designations.

W. S. REESE.

NEUROBLASTOMA OF THE ADRENAL WITH ORBITAL METASTASES. R. N. SHAFFER, Am. J. Ophth. **30: 733** (June) 1947.

Shaffer reports 5 cases of neuroblastoma of the Hutchinson type with autopsy observations. He emphasizes the importance of roentgenologic evidence of calcification above the kidney as a diagnostic aid. Radioactive phosphorus has been unsuccessful in the treatment of these patients.

W. S. REESE.

LYMPHOCYTOMA OF THE ORBIT SUCCESSFULLY TREATED BY ROENTGEN IRRADIATION. S. VAN WIEN, Am. J. Ophth. **31:** 209 (Feb.) 1948.

Van Wien presents a case of lymphocytoma of the orbit. The diagnosis was established by means of biopsy, and satisfactory response to roentgen therapy was obtained. W. S. REESE.

ORIGIN OF THE MALIGNANT MELANOMATA. E. WOLFF, Brit. J. Ophth. **33:** 72 (Feb.) 1948.

Wolff is opposed to the theory of a unitary origin of malignant melanoma. He believes that the nevus should be regarded as a composite, or mixed, tumor, consisting for the present purpose of nevus cells, epithelial cells and branched chromatophores. Each of these elements may proliferate alone or with the others to produce a malignant pigmented tumor. The final structure will depend on the relative proportions of the three types of cell. W. ZENTMAYER.

Uvea

RELATION OF ALLERGY TO ACUTE IRITIS. P. LEMOINE, Arch. d'opht. **7:** 161, 1947.

In recent years many authors have been inclined to attribute to allergy ocular conditions of uncertain cause which apparently are not due to a infectious process. The author summarizes three theories. The first is that of the liberation of histamine and the use of antihistamine drugs. The second theory is that of an antigen-antibody reaction, producing a flocculation of colloids, which, in turn, leads to vascular disturbances and to imbalance in control of the sympathetic nervous system. Magnesium hyposulfite has been used to prevent this process. A third theory incriminates the vascular endothelium. The author used magnesium hyposulfite in a series of 30 cases of acute iritis. These cases were divided into two groups: those in which regular injections were given and those in which the injection was difficult. In 8 of the 10 cases in the first group improvement was much more rapid than in the second group. The technic of the injections is given. A daily intravenous injection of 10 cm. of a 10 per cent solution of the drug is used for the first five or six days. The injections are then spaced according to the progress of the condition. The author cites 3 significant cases in which improvement was definitely more rapid. It was surprising that the antiallergic treatment was favorable in 25 of 30 cases, and the first case was especially interesting in that there seemed to be a close relation between the iritis and an intestinal disturbance. The author expresses the belief that the allergic hypothesis does not contraindicate the use of an etiologic medication. Hyposulfite intervenes only to check whatever allergic consequences may be present. In the majority of cases both types of treatment should be employed concurrently in order to obtain the maximum benefit to the patient. S. B. MARLOW.

Vision

BINOCULAR VISION. D. CAMPBELL, Brit. J. Ophth. **31:** 321 (June) 1947.

In this paper the Middlemore Lecture, Campbell reviews and analyzes the literature. As the common disorders of binocular vision, she

gives primary amblyopia and the allied condition of suppression; strabismus, both paralytic and concomitant, and heterophoria.

The factors contributing to maintenance of perfect binocular vision in man are the overlapping of the visual fields, a strongly developed sense of fusion and the dominance of macular over peripheral vision. The maintenance of perfect binocular vision must depend on a bilateral harmony within the central area of the two mechanisms of pattern vision and fusion.

The author has found that good binocular vision persists in the dark-adapted eye, even when the illumination of the test object is so low as to favor rod, rather than cone, vision. The author has arrived at the same conclusion as Verhoeff, that binocular vision depends on some form of physiologic replacement.

Occlusion should not be left, as it so often is in the case of the hospitalized child, until the age of 5. It can be employed much earlier, or perhaps a better method is the use of atropine drops in the good eye.

W. ZENTMAYER.

Vitreous

OPERATIVE TECHNIC OF VITREOUS REPLACEMENT. M. H. FEITZ, T. M. FENNESSY and H. CABRERA, Am. J. Ophth. **30:** 1221 (Oct.) 1947.

This article describes the technic of replacement of vitreous with cerebrospinal fluid. This procedure was carried out on refrigerated human eyes. A plea is made for ophthalmologists to use this method in suitable cases.

W. S. REESE.

TRANSPLANTATION OF VITREOUS: A PRELIMINARY REPORT. H. M. KATZIN and J. BLUM, Brit. J. Ophth. **31:** 760, (Dec.) 1947.

A brief chronologic survey of the attempts made to remove vitreous without replacement or to replace it with saline solution, air or animal vitreous is given. The authors give the following summary of their experimental work: Transfer of vitreous was studied in 39 rabbit eyes, with a follow-up period of six months. Several types of procedure were used; these are described in the text, and a comparison of these procedures in the experimental animal and in the human eye is discussed.

Traumatic cataract was produced in 2 cases; retinal detachments which persisted occurred in 6 cases, and localized proliferation of fibrous tissue around the site of puncture, in 7 cases. These complications, particularly the retinal detachment, are significant and should be borne in mind in the election of vitreous transfer as a clinical procedure.

W. ZENTMAYER.

Therapeutics

AN ATTEMPT TO TREAT A PERFORATED EYE WITH SUBCONJUNCTIVAL PENICILLIN. F. R. NEUBERT, Brit. J. Ophth. **32:** 162 (March) 1948.

The eyeball had been perforated through the cornea by a wire. On the second day 50,000 units of penicillin in epinephrine and "nuvatox" was injected subconjunctivally and 30,000 units was given intramuscularly. This subconjunctival injection was repeated twice. On the

fifth day the eye was enucleated because of beginning panophthalmitis. The diagnosis was confirmed pathologically. W. ZENTMAYER.

TISSUE THERAPY OF OCULAR COMPLICATIONS IN PATIENTS WITH HYPERTENSION. D. BUSHMITCH, Oftal. zhur. **2:** 36, 1946.

During the siege of Leningrad, in 1942, the oculists were the first to observe the increase of hypertension because of the frequency of angiospastic retinitis among patients at the ophthalmic clinics.

Twenty-four patients with hypertension accompanied with retinal changes, hemorrhages, neuroretinitis and atrophy of the optic nerve (4 patients) were treated with injections of autoclaved preserved leaves of aloe combined with implantations of preserved skin of the cadaver. In all patients improvement in the general condition (in 11, the blood pressure was lowered) and in the fundus picture was observed; most of the retinal hemorrhages were absorbed; the edema of the disk decreased, and in the majority vision improved. The headaches disappeared in several cases. The effect of the treatment was not permanent, and the injections had to be repeated in two to three months. The treatment was given ambulatory patients. O. SITCHEVSKA.

TISSUE THERAPY OF TRAUMATIC CHANGES OF THE VITREOUS IN THE PERIOD OF WORLD WAR II. I. ERSHKOVICH, Vestnik oftal. **25:** 16, 1946.

The statistical data of World War II indicate that hemorrhages into the vitreous occur in from 17 to 58 per cent of all cases of ocular injury. Ershkovich analyzes the various end results of hemorrhage in the vitreous and the various methods of treatment applied by the Soviet ophthalmologists.

He used tissue therapy in 20 cases of opacities in the vitreous resulting from war injuries in a military hospital. In 2 cases the injury was caused by a bullet; in the others, by fragments of mines and grenades. In 14 cases there was a penetrating injury, and in 6, contusion of the eyeball. In all cases there were severe complications from the injury: intraocular foreign bodies, 6 cases; retinal detachment, 7 cases, and proliferative retinitis, 2 cases. In 3 cases the remaining eye was affected, the other eye having been enucleated at the front.

Tissue therapy was applied from one to nine months after the injury. In 10 cases it was combined with osmotherapy, and in the other 10 cases it was used alone. Implantation of preserved placenta beneath the skin of the ear or under the conjunctiva; intramuscular injections of cod liver oil, and subcutaneous injections of preserved blood were used. In 17 cases repeated courses of tissue therapy were employed. The time of observation was from three months to two and one-half years.

Tissue therapy gave improvement in 18 cases, including those of intraocular foreign bodies and detachment of the retina. Vision was improved in many cases from light projection and counting fingers to 0.05, 0.1 or 0.4.

Ershkovich urges the use of tissue therapy in traumatic changes of the vitreous, even in apparently hopeless cases.

OLGA SITCHEVSKA.

Book Reviews

Oculus: Tabulae Biologicae. Volume 32, Part I. Edited by K. Steindorff, F. P. Fischer, J. S. Friedenwald and Arnold Sorsby. Price, 60 florins. Pp. 408. Amsterdam: Netherlands, Ultgeverij W. Junk, 1947.

The thirteenth volume of the "Tabulae Biologicae," which is devoted to the eye, has been planned for publication in four parts. The first part has now appeared in print, about ten years after work on this great undertaking was initiated. Morphologic data are presented in the chapters on the eye of the invertebrates, by H. Kahmann; the metric and descriptive characteristics of the human and the animal eye, by St. Martin-Oppenheim, and the descriptive anatomy of the vertebrate and the human eye, by K. Steindorff, as well as in the brief section on the embryology of the vertebrate eye, by C. Dejean and F. Granel. In the three additional divisions, J. Nordmann discusses the anatomic, physiologic and pharmacologic aspects, and K. W. Ascher, intraocular pressure and blood pressure in the ocular vessels.

The descriptive and comparative anatomic material is almost exclusively presented in the form of tables, without connecting or explanatory text except for the condensed treatise on embryology. The amount of information embodied in the tables is overwhelming. It is collected from widespread sources, and as a presentation of facts nothing on the oculist's bookshelf is comparable to it. A good, although not complete, list of references pertaining to the tabulated data is appended to each section. This will enable the reader to judge the statistical value or significance of the findings and measurements tabulated by returning to the original papers. In the chapters concerned with the embryologic, physiologic and pharmacologic phases, the subject matter is described with a minimum of words, without discussion or comment. The authors obviously adhere to the primary purpose of the work, namely, to convey facts, not theories.

The ophthalmologist will be attracted first by the instructive and exhaustive section on anatomy, by Steindorff, and by the sections on intraocular pressure and blood pressure in the ocular vessels, by Ascher. It is true that none of these sections is complete or brought up to date, as the literature published after 1937 either is not or is insufficiently covered; but this disadvantage is compensated for by a concise presentation of a stupendous mass of measurements and results in the various phases of ocular anatomy and physiology.

Not only will this monumental piece of work serve as a book for reference in biologic libraries and research laboratories, but the facts which it offers will often provide satisfactory answers to questions occurring in investigative work. It will be necessary to make the abundance of information in this book readily accessible by a good index. In fact, the completeness of such an index will determine the practical value of the book.

LUDWIG VON SALLMANN, M.D.

Ophthalmology in the War Years. Volume 2 (1944—June 1946). Edited by Meyer Wiener, M.D. Price, $16. Pp. 977. Chicago: The Year Book Publishers, Inc., 1948.

With the appearance of the second volume, ophthalmologic literature during the war years has now been completely covered. Owing to the difficulty in obtaining scientific articles and books during the war years, ophthalmologists will value the completion of this series and add the expression of their thanks to Dr. Wiener and to his admirable group of associate editors. The labor and painstaking diligence which the collection of the titles and the writing of the review articles must have taken testify to the altruism and devotion of the editors. New chapters have been added and some omissions in the first volume, reviewed in the ARCHIVES (**37:** 258 [Feb.] 1947) have been corrected.

The subjects and their authors are as follows: "Anatomy and Embryology," John J. Prendergast; "Biochemistry, Pharmacology and Toxicology," W. Morton Grant and David G. Cogan; "Chemical Warfare Agents: Effects on the Eye and Their Treatment," Jonas S. Friedenwald and William F. Hughes Jr.; "Color Deficiency," Louise L. Sloan; "Comparative Ophthalmology," Helenor Campbell Wilder; "Congenital Anomalies," Arthur M. Yudkin; "Conjunctiva," Edward P. Burch; "Cornea and Sclera," Ramon Castroviejo; "Corneal Epithelium: Mitosis and Wound Healing," Jonas S. Friedenwald; "Electrophysiology," S. Howard Bartley; "Experimental Pathology" Peter C. Kronfeld; "General Pathology and Bacteriology," S. Rodman Irvine and Mary Dailey Irvine; "Glaucoma," Otto Barkan; "Hygiene, Sociology, Education and History," Windsor S. Davies; "Industrial Ophthalmology," Hedwig S. Kuhn; "Injuries," Robert J. Masters; "The Lens," Ray K. Daily and Louis Daily Jr.; "Lids and Lacrimal Apparatus," Harold F. Whalman; "Methods of Examination," Leo L. Mayer, "Neuro-Ophthalmology," P. J. Leinfelder; "Ocular Neuromotor Mechanism," George P. Guibor; "Orbit, Eyeball and Sinuses," William L. Benedict; "Physiologic Optics," Kenneth N. Ogle; "The Pupil," Henry Minsky; "Refraction and Accommodation," E. Merle Taylor; "Relationship of the Eye to the Nose and Throat," W. Nicholas Sauer; "Retina and Vitreous," Hugo Lucic; "Surgery of the Eye," Bennett Y. Alvis and Edmund B. Alvis; "Systemic Diseases; Syphilis; Parasites," Joseph Igersheimer; "Therapeutics," Frederick C. Cordes; "Trachoma," Phillips Thygeson; "Tumors," Jack S. Guyton, and "Uveal Tract," William M. James.

A brief study of the text will convince the reader of the excellence of the reviews and the completeness of the subjects listed. Again, our thanks to Dr. Wiener and his associates for this admirable volume.

ARNOLD KNAPP.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Dr. A. Churchill, 66 Boulevard Saint-Michel, Paris, 6e, France.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

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Secretary: Dr. Halger Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

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Secretary: Mr. A. G. Cross, 27 Harley St., London W. 1.

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Secretary: Dr. D. S. Shen, Eye, Ear, Nose and Throat Hospital, Chengtu, Szechuan, China.
Place: Eye, Ear, Nose and Throat Hospital, Chengtu, Szechuan, China.

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Secretary: Dr. F. S. Tsang, 221 Foochow Rd. Shanghai.

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Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

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All correspondence should be addressed to the Assistant Secretary.

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Place: Birmingham and Midland Eye Hospital.

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Place: Manchester, Leeds, Newcastle-upon-Tyne, Liverpool, Sheffield and Bradford, in rotation. Time: October to May.

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Place: Melbourne. Time: October 1949.

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All correspondence should be addressed to the secretary, Dr. Mohammed Khalil.

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Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

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Place: Various Central Illinois towns. Time: Two meetings a year.

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Secretary-Treasurer: Dr. Robert T. Wong, 1147 Union, Honolulu.
Place: Pacific Club, Honolulu. Time: Third Thursday of each month.

INTER-MOUNTAIN OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. James A. Cleary, 804 Boston Bldg., Salt Lake City.
Secretary-Treasurer: Dr. Homer E. Smith, 1105 Medical Arts Bldg., Salt Lake City.
Place: University Club, Salt Lake City. Time: 7:00 p. m., third Monday of each month, September through May.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. John E. Rice, 390 Main St., Worcester, Mass.
Secretary-Treasurer: Dr. Garrett L. Sullivan, 101 Bay State Rd., Boston 15.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Wednesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. Guy Boyden, 1735 N. Wheeler Ave., Portland 12, Ore.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco 8.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Robert Wightman, 1114 Boylston Ave., Seattle, Wash.
Secretary-Treasurer: Dr. Barton E. Peden, 301 Stimson Bldg., Seattle 1, Wash.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Robert C. Finger, RFD New Tower, Rockford, Ill.
Secretary-Treasurer: Dr. Vernon C. Voltz, 625 Gas-Electric Bldg., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. James Curts, 127 S. Washington Ave., Saginaw, Mich.
Secretary-Treasurer: Dr. V. E. Cortopassi, 324 S. Washington Ave., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July, August and September.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. M. W. Eggers, Sioux Falls, Iowa.
Secretary-Treasurer: Dr. W. P. Davey, 2101 Grandview Blvd., Sioux City 18, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Shaler Richardson, 111 W. Adams, Jacksonville 2, Fla.
Secretary: Dr. Alston Callahan, 908 S. 20th St., Birmingham 5, Ala.
Time: First week in November.

SOUTHWESTERN ACADEMY OF EYE, EAR, NOSE AND THROAT

President: Dr. H. L. Brehmer, 221 W. Central Ave., Albuquerque, N. Mex.
Secretary: Dr. A. E. Cruthirds, 1011 Professional Bldg., Phoenix, Ariz.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. W. M. Dodge, 716 First National Bank Bldg., Battle Creek.
Secretary-Treasurer: D. Kenneth Lowe, 25 W. Michigan Ave., Battle Creek.
Time: Last Thursday of September, October, November, March, April and May.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Paul McCloskey, 338 Locust St., Johnstown.
Secretary-Treasurer: Dr. Fred E. Murdock, 28½ W. Scribner St., Dubois.

STATE

ARKANSAS STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. R. W. Kirkpatrick, Texarkana.
Secretary: Dr. K. W. Cosgrove, 115 E. Capitol, Little Rock.

COLORADO OPHTHALMOLOGICAL SOCIETY

President: Dr. Ralph W. Danielson, 324 Metropolitan Bldg., Denver 2.
Secretary: Dr. James C. Strong Jr., 617 Majestic Bldg., Denver 2.
Place: University of Colorado Medical Center, Denver. Time: 7:30 p. m., third Saturday of each month, September to May, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. W. H. Turnley, 1 Atlantic St., Stamford, Conn.
Secretary-Treasurer: Dr. Morton W. Arnold, 29 North St., Willimantic, Conn.

GEORGIA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. N. Maner, Savannah.
Secretary-Treasurer: Dr. B. E. Collins, 701 Elizabeth St., Waycross.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Russell A. Sage, 23 E. Ohio St., Indianapolis.
Secretary: Dr. D. Hamilton Row, 23 E. Ohio St., Indianapolis.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. P. Weih, 217–5th Ave. E., Clinton.
Secretary-Treasurer: Dr. A. A. Noe, 601 Higley Bldg., Cedar Rapids.

KANSAS STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. B. J. Ashley, Topeka.
Secretary: Dr. N. L. Francis, 214 Orpheum Bldg., Wichita.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.
Secretary: Dr. Charles R. Hume, 1301 Washington St., Vicksburg, Miss.
Place: The Buena Vista Hotel, Biloxi, Miss. Time: May 9, 1949.

MEDICAL SOCIETY OF THE STATE OF PENNSYLVANIA, SECTION ON EYE, EAR, NOSE AND THROAT DISEASES

Chairman: Dr. William T. Hunt Jr., 1205 Spruce St., Philadelphia 7.
Secretary: Dr. Gabriel Tucker, 250 S. 18th St., Philadelphia 3.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Ralph H. Gilbert, 110 Fulton St. E., Grand Rapids.
Secretary: Dr. Walter Z. Rundles, 620 Maxine Ave., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. A. D. Prangen, Mayo Clinic, Rochester.
Secretary-Treasurer: Dr. Frank Adair, Mayo Clinic, Rochester.
Place: Minneapolis Club. Time: 6:00 p. m., second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. F. Knierim, Glasgow.
Secretary: Dr. Fritz D. Hurd, 309 Medical Arts Bldg., Great Falls.

NEBRASKA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. John Peterson, 1307 N St., Lincoln.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. John P. Brennan, 429 Cooper St., Camden.
Secretary: Dr. A. M. K. Maldeis, 117 N. 6th St., Camden.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Thomas H. Johnson, 30 W. 59th St., New York.
Secretary: Dr. Darrell G. Voorhees, 135 E. 65th St., New York 21.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. V. K. Hart, 106 W. 7th St., Charlotte.
Secretary: Dr. J. A. Harrill, Bowman Gray School of Medicine, Winston-Salem.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. L. Reichert, Dickinson.
Secretary-Treasurer: Dr. M. T. Lampert, Minot.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Floyd Dunnavan, 14 Riverside Dr., Vancouver, Wash.
Secretary-Treasurer: Dr. C. W. Kuhn, 1020 S. W. Taylor St., Portland 5.
Place: Heathman Hotel, Portland. Time: 6:30 p. m., third Tuesday of each month.

PENNSYLVANIA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Gilbert L. Dailey, 618 N. 3d St., Harrisburg.
Secretary: Dr. Benjamin F. Souders, 143 N. 6th St., Reading.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society, Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Richard W. Hanckel, 96A Bull St., Charleston.
Secretary-Treasurer: Dr. Roderick Macdonald, 330 E. Main St., Rock Hill.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Burchfield, Maryville.
Secretary-Treasurer: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. W. E. Vandevere, 1001 First National Bank Bldg., El Paso.
Secretary: Dr. E. D. Dumas, 425 Medical Arts Bldg., San Antonio.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Fred Hamlin, 30½ Franklin Rd. S.W., Roanoke.
Secretary-Treasurer: Dr. Francis H. McGovern, 105 S. Union St., Danville.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. John D. Brumbaugh, Second National Bldg., Akron 8, Ohio.
Secretary-Treasurer: Dr. A. L. Peter, 406 Akron Savings & Loan Bldg., Akron 8, Ohio.
Place: Akron City Club. Time: 6:30 p. m., first Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Alton V. Hallum, 478 Peachtree St. N. E., Atlanta, Ga.
Secretary: Dr. James T. King, Medical Arts Bldg., Atlanta, Ga.
Place: Academy of Medicine. Time: 7:30 p. m., fourth Monday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Edwin F. Knowles Jr., 513 N. Charles St., Baltimore.
Secretary: Dr. James I. Moore, 11 E. Chase St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to March.

BIRMINGHAM EYE, EAR, NOSE AND THROAT CLUB

President: Each member, in alphabetical order.
Secretary: Dr. W. Chunn Parsons, 425 Woodward Bldg., Birmingham, Ala.
Place: Thomas Jefferson Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frank E. Mallon, 1 Hanson Pl., Brooklyn 16.
Secretary-Treasurer: Dr. Louis Freimark, 256 Rochester Ave., Brooklyn 13.
Place: Towers Hotel, 25 Clark St. Time: 8:15 p. m., third Thursday in February, April, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo 9.
Secretary-Treasurer: Dr. Herbert R. Reitz, 446 Linwood Ave., Buffalo 9.
Place: Park Lane. Time: Second Thursday of each month from October to May.

CENTRAL NEW YORK EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. John R. Myers, State Tower Bldg., Syracuse.
Secretary-Treasurer: Dr. Alfred W. Doust, 306 State Tower Bldg., Syracuse.
Time: 7:00 p. m., fourth Wednesday of alternate months.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. Willard H. Steele Jr., Providence Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Arlington C. Krause, 1236 E. 57th St., Chicago 37.
Secretary: Dr. J. R. Fitzgerald, 30 N. Michigan Ave., Chicago 2.
Place: Illini Union Bldg. Time: 7:30 p. m., third Monday of each month from October to May.

Cincinnati Ophthalmologic Club

Chairman: Rotate alphabetically.
Secretary: Dr. Josef D. Weintraub, Provident Bank Bldg., Cincinnati.
Place: Cincinnati General Hospital. Time: 8:00 p. m., second Friday of each month from November to May, inclusive.

Cleveland Ophthalmological Club

Chairman: Dr. M. W. Jacoby, 1364 Hanna Bldg., Cleveland 15.
Secretary: Dr. Roscoe J. Kennedy, 2020 E. 93d St., Cleveland 6.
Place: Hotel Statler, Cleveland. Time: Second Tuesday in November, January, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Perce de Long, 37 S. 20th St., Philadelphia.
Clerk: Dr. M. Luther Kauffman, Medical Arts Bldg., Jenkintown, Pa.
Place: College of Physicians Bldg. Time: 8:15 p. m., third Thursday of every month from October to May, inclusive.

Columbus Eye, Ear, Nose and Throat Society

Chairman: Dr. E. Harris, 240 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. W. J. Miller, 21 E. State St., Columbus, Ohio.
Place: University Club. Time: 6:00 p. m., first Monday of each month, from October to May, inclusive.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. June Yates, 210 Medical Professional Bldg., Corpus Christi, Texas.
Secretary: Dr. B. B. Friedman, Jones Bldg., Corpus Christi, Texas.
Place: Nueces Hotel. Time: 6:30 p. m., third Tuesday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. L. Darrough, 4105 Live Oak St., Dallas, Texas.
Secretary: Dr. C. A. Hoefer, 1719 Pacific Ave., Dallas 1, Texas.
Place: Melrose Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. Byron Merkel, 1112 Equitable Bldg., Des Moines, Iowa.
Secretary-Treasurer: Dr. H. H. Grau, 213 Bankers Trust Bldg., Des Moines, Iowa.
Place: Des Moines Club. Time: Second Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Wesley G. Reid, 974 Fisher Bldg., Detroit 2.
Place: Club rooms of Wayne County Medical Society. Time: Third Thursday of each month, November to April, inclusive.

Detroit Ophthalmological Society

President: Dr. Bruce Fralick, 201 S. Main St., Ann Arbor, Mich.
Secretary: Dr. William S. Gonne, 619 David Whitney Bldg., Detroit 26.
Place: Hayler's L'Aiglon Bldg. Time: 6:30 p. m., third Thursday of each month from November to April, inclusive.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. Joseph L. Holohan, 330 State St., Albany.
Secretary-Treasurer: Dr. E. Martin Freund, 762 Madison Ave., Albany 3.
Place: Albany, Troy, Schenectady, rotating monthly. Time: First Thursday of every month.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. John Eschenbrenner, 306 W. Broadway, Fort Worth, Texas.
Secretary-Treasurer: Dr. C. Keith Barnes, 921 Neil P. Anderson Bldg., Fort Worth 2, Texas.
Place: All Saints Hospital. Time: 6:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Ophthalmological and Oto-Laryngological Section

President: Dr. Norma B. Elles, Niels Esperson Bldg., Houston, Texas.
Secretary: Dr. R. Marion Johnson, Medical Arts Bldg., Houston, Texas.
Place: River Oaks Country Club. Time: 6:30 p. m., second Thursday of each month from October to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Secretary: Dr. J. Lawrence Sims, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Alvin J. Baer, 1102 Grand Ave., Kansas City, Mo.
Secretary: Dr. James W. May, 906 Grand Ave., Kansas City, Mo.
Time: 6:00 p. m., third Thursday of each month from November to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Oliver R. Nees, Times Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Orville W. Cole, 305 Professional Bldg., Long Beach 2, Calif.
Place: Seaside Hospital. Time: 6:15 p. m., third Wednesday of each month from October to May.

Los Angeles Ophthalmological Society

Chairman: Dr. Orwyn Ellis, 727 W. 7th St., Los Angeles 14.
Secretary: Dr. John A. Bullis, 3875 Wilshire Blvd., Los Angeles 5.
Place: 3550 Wilshire Blvd., Los Angeles. Time: 6:30 p. m., third Tuesday of each month, September through June.

Los Angeles Society of Ophthalmology and Otolaryngology

President: Dr. Colby Hall, 1136 W. 6th St., Los Angeles.
Secretary-Treasurer: Dr. Warren A. Wilson, 1930 Wilshire Blvd., Los Angeles 5.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye and Ear Society

President: Dr. Joseph S. Heitger, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. W. Fish, 321 W. Broadway, Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Lower Anthracite Eye, Ear, Nose and Throat Society

Chairman: Each member in alphabetical order.
Secretary: Dr. James J. Monohan, 31 S. Jardin St., Shenandoah, Pa.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. P. S. Constantinople, 1835 I St. N. W., Washington.
Secretary: Dr. Frazier Williams, 1801 I St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month from September to May.

Milwaukee Oto-Ophthalmic Society

President: Dr. Frank G. Treskow, 411 E. Mason St., Milwaukee 2.
Secretary-Treasurer: Dr. George O. Dunker, 208 E. Wisconsin Ave., Milwaukee.
Place: Athletic Club. Time: 6:30 p. m., fourth Tuesday of each month from October to May.

Montgomery County Medical Society

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel: Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. B. Alexander, Medical Arts Bldg., Montreal, Canada.
Secretary: Dr. R. Cloutier, 3445 Papineau Ave., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Eugene Orr, Doctors Bldg., Nashville 3, Tenn.
Secretary: Dr. N. B. Norris, Doctors Bldg., Nashville 3, Tenn.
Place: James Robertson Hotel. Time: 6:30 p. m., third Monday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. Charles A. Bahn, Maison Blanche Bldg., New Orleans.
Secretary: Dr. Mercer G. Lynch, Ochsner Clinic, New Orleans.
Place: Charity Hospital. Time: 8 p. m., first Tuesday of every month.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Wendell L. Hughes, 131 Fulton Ave., Hempstead, N. Y.
Secretary: Dr. Isadore Givner, 108 E. 66th St., New York 21.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Benjamin Esterman, 983 Park Ave., New York 28.
Secretary: Dr. Leon Ehrlich, 211 Central Park W., New York.
Place: New York Academy of Medicine, 2 E. 103d St. Time: 8 p. m., first Monday of each month from October to May, inclusive.

OKLAHOMA CITY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. William Mussil, Medical Arts Bldg., Oklahoma City.
Secretary: Dr. Charles A. Royer, 717 Medical Arts Bldg., Oklahoma City.
Place: University Hospital. Time: 7:30 p. m., first Tuesday of each month from September to June.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Robert H. Rasgorshek, 425 Aquila Court, Omaha.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha 2.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m. dinner; 7 p. m. program; third Wednesday of each month from October through April.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. Thomas Sanfacon, 340 Park Ave., Paterson, N. J.
Secretary-Treasurer: Dr. J. Averbach, 435 Clifton Ave., Clifton, N. J.
Place: Doctors Lounge, Paulsen Medical and Dental Bldg. Time: 8 p. m., last Tuesday of each month except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

President: Dr. L. Waller Deichler, 1930 Chestnut St., Philadelphia 3.
Secretary: Dr. Robert T. M. Donnelly, 255 S. 17th St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Robert J. Billings, Jenkins Arcade, Pittsburgh.
Secretary: Dr. Samuel D. Evans, Park Bldg., Pittsburgh 22.
Place: Pittsburgh Academy of Medicine Bldg. Time: 8:00 p. m., fourth Monday of each month, except June, July, August and September.

READING EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. John M. Wotring, 220 N. 6th St., Reading, Pa.
Secretary: Dr. Paul C. Craig, 232 N. 5th St., Reading, Pa.
Place: Wyomissing Club. Time: 6:00 p. m., third Wednesday of each month from September to July.

RICHMOND EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. DuPont Guerry III, Professional Bldg., Richmond, Va.
Secretary: Dr. George N. Thrift, Medical Arts Bldg., Richmond, Va.
Place: Commonwealth Club. Time: 6 p. m., first Tuesday of January, March May and October.

ROCHESTER EYE, EAR, NOSE AND THROAT CLUB

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.

St. Louis Ophthalmic Society

President: Dr. T. E. Sanders, 3720 Washington Blvd., St. Louis 8.
Secretary: Dr. J. H. Bryan, 327 Beaumont Bldg., St. Louis 8.
Place: Elliott Auditorium, McMillan Hospital. Time: Fourth Friday of each month from October to April, inclusive, except December, at 8:00 p. m.

San Antonio Society of Ophthalmology and Otolaryngology

President: Dr. T. W. Folbre, Nix Professional Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. A. F. Clark Jr., 827 Medical Arts Bldg., San Antonio 5, Texas.
Place: San Antonio, Texas, Brooke General Hospital and Randolph Field. Time: 7 p. m., second Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. J. W. Bettman, 2400 Clay St., San Francisco 15.
Secretary: Dr. William Duggan, 490 Post St., San Francisco 2.
Place: Society's Bldg., 2180 Washington St., San Francisco 9. Time: 8:15 p. m., fourth Tuesday of every month except June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. Ralph Riggs, Medical Arts Bldg., Shreveport, La.
Secretary-Treasurer: Dr. Frank L. Bryant, 2622 Greenwood Rd., Shreveport 2, La.
Place: Shreveport Club. Time: 6:30 p. m., first Monday of every month except June, July and August.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Charles M. MacKenzie, Paulsen Medical and Dental Bldg., Spokane, Wash.
Secretary: Dr. Raymond A. Lower, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Library, Paulsen Medical and Dental Bldg. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Toledo Eye, Ear, Nose and Throat Society

Chairman: Dr. W. W. Randolph, 1838 Parkwood Ave., Toledo 2, Ohio.
Secretary: Dr. John L. Roberts, 316 Michigan St., Toledo, Ohio.
Place: Toledo Club. Time: 6:30 p. m., each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

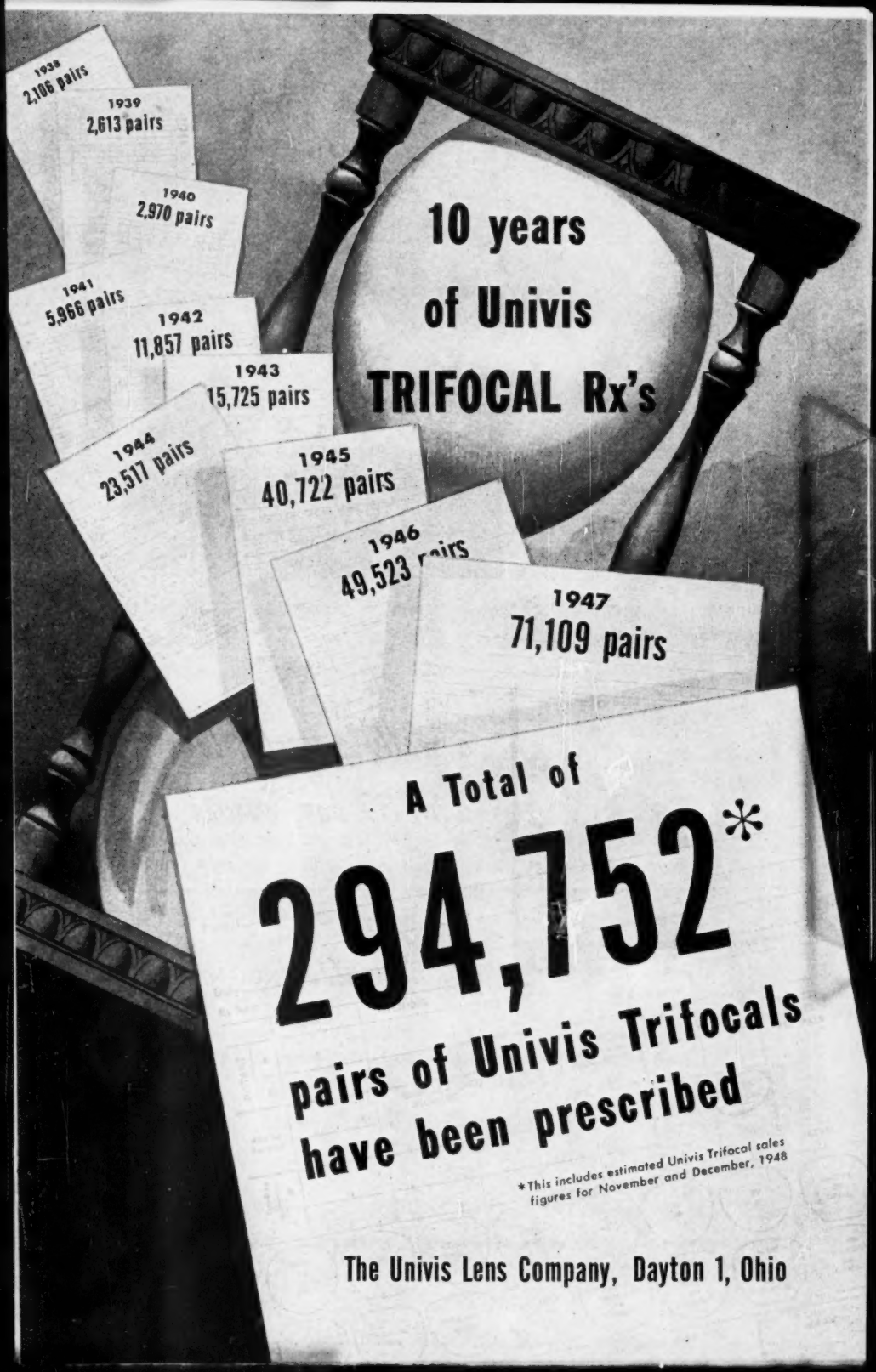
Chairman: Dr. H. M. Macrae, Medical Arts Bldg., Toronto, Canada.
Secretary: Dr. J. C. McCulloch, 830 Medical Arts Bldg., Toronto 5, Canada.
Place: Academy of Medicine, 288 Bloor St. W. Time: 8:00 p. m., second Tuesday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. Jerome A. Sansoucy, 2017 Massachusetts Ave. N. W., Washington, D. C.
Secretary: Dr. Thomas A. Egan, 1835 Eye St. N. W., Washington, D. C.
Place: Medical Society of District of Columbia Bldg., 1718 M St. N. W., Washington, D. C. Time: 8:00 p. m., first Monday of November, January, March and May.

Wilkes-Barre Ophthalmological Society

Chairman: Dr. W. C. Marsden, 99 N. Franklin St., Wilkes-Barre, Pa.
Secretary: Dr. Samuel T. Buckman, 70 S. Franklin St., Wilkes-Barre, Pa.
Place: Luzerne County Medical Society. Time: Last Tuesday of each month from October to May.


1938
2,106 pairs
1939
2,613 pairs
1940
2,970 pairs
1941
5,966 pairs
1942
11,857 pairs
1943
15,725 pairs
1944
23,517 pairs
1945
40,722 pairs
1946
49,523 pairs
1947
71,109 pairs
10 years
of Univis
TRIFOCAL Rx's
A Total of
294,752*
pairs of Univis Trifocals
have been prescribed
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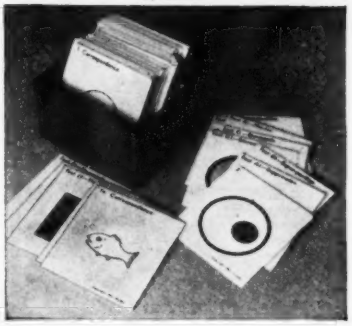

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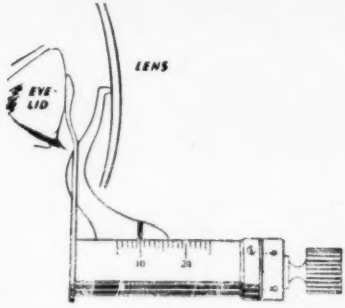

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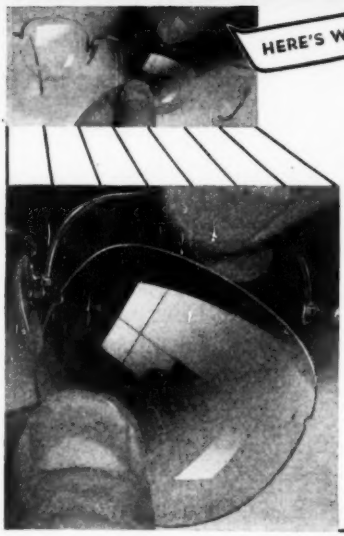

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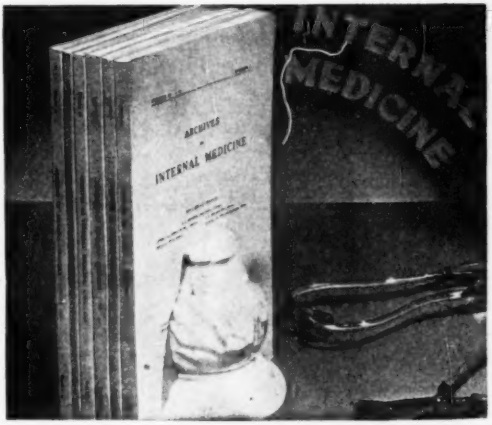

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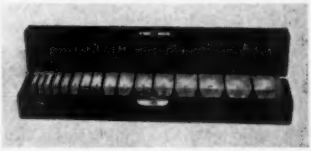

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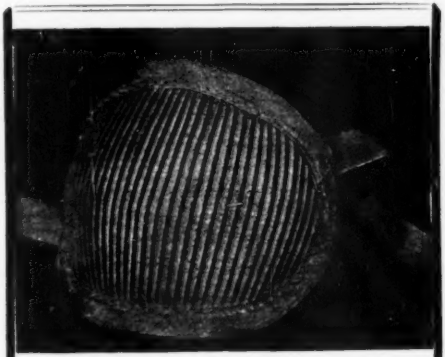

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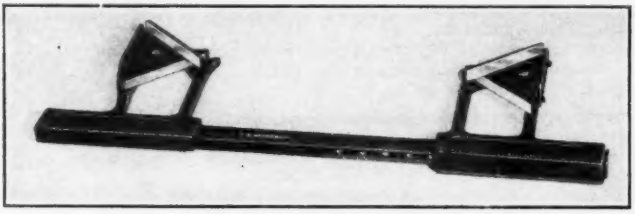

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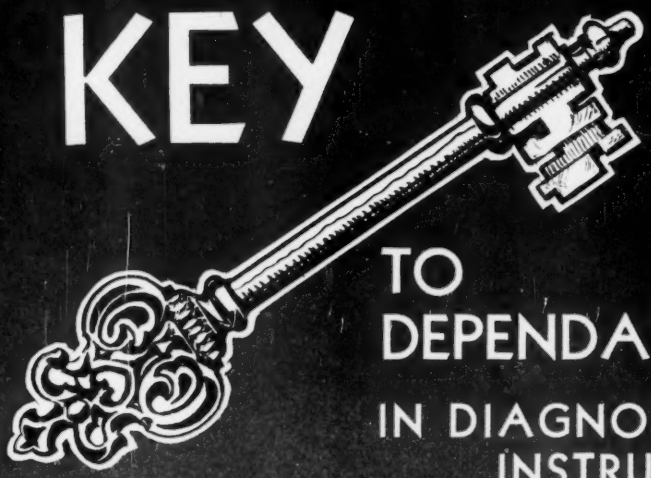

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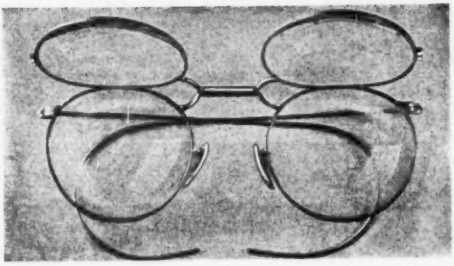

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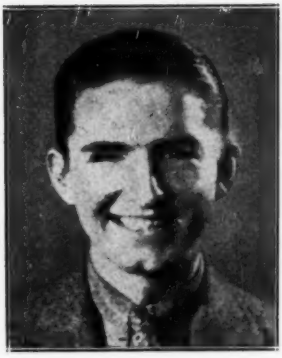

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